WSRC-RP-92-989
Revision 2
November, 1998

Safety Analysis Report for the SR-101 Inert Reservoir Package(U)

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under Contract NO. DE-AC09-96SR18500

DISCLAIMER

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

(This page intentionally left blank)

APPROVALS

Signature _____ Date 11/19/98
E. K. Opperman (Manager, Packaging and Transportation Group)

Signature _____ Date 19 Nov 98
M. A. Ebra (Manager, Engineering Development Section)

Signature _____ Date 11/19/98
J. R. McCowan (Manager, 233/234-H Engineering)

Signature _____ Date 11/18/98
D. E. LaPierre (Manager, 234-H Operations)

(This page intentionally left blank)

ACKNOWLEDGMENTS

Acknowledgment to Don Hoang of the Packaging and Transportation Group for his significant support in performing calculations and data analysis and to Jerry W. Corbett of the Experimental Thermal Hydraulics Group for his package design support and fabrication of a SR-101 prototype to demonstrate operational features of the design.

(This page intentionally left blank)

PREFACE

Department of Energy (DOE) AL Weapons Surety Division (WSD) requires the SR-101 Inert Reservoir Package to meet applicable hazardous material transportation requirements. This Safety Analysis Report (SAR) is based on requirements in place at the time of packaging development (ca. 1992). Both DOE Order 5610.1, *Packaging and Transporting of Nuclear Explosives, Nuclear Components, and Special Assemblies*, and AL Supplemental Directive 5610.1, Rev. 1, *Packaging and Transportation of Components and Special Assemblies Associated with the Nuclear Weapons Program*, Chapter III, provide the requirement to prepare a safety analysis report. DOE Order 5610.1 requires that "nuclear explosives, nuclear components, and special assemblies must be packaged and transported to provide a level of safety at least comparable to that provided by the packaging and shipment, in accordance with applicable regulations, of other radioactive and explosive material". AL Supplemental Directive 5610.1, Rev. 1, restates this requirement for nuclear components and special assemblies. Specifically, the supplemental directive states these items will be shipped in packages that shall achieve a similar or higher level of protection compared to that provided by federally specified transportation requirements for other hazardous, radioactive, and explosive materials.

The reservoirs do not meet all the requirements for shipment as a DOT Specification package. To demonstrate compliance with the requirements set forth in DOE Order 5610.1, the format and content for a DOE alternative per DOE Order 1540.2, Chapter IV, is followed. The SAR provides the basis for the determination that the SR-101 Inert Reservoir Package provides a level of safety at least comparable to that provided by a package with the same contents shipped in accordance with the applicable DOT regulations.

(This page intentionally left blank)

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

(This page intentionally left blank)

I. INTRODUCTION

I.A Purpose

The Safety Analysis Report (SAR) demonstrates that the SR-101 Inert Reservoir Package, comprised of various reservoirs within a drum overpack, provides the transportation safety required by the DOE Order 5610.1, *Packaging and Transporting of Nuclear Explosives, Nuclear Components, and Special Assemblies,*[1] and DOE Albuquerque Field Office (DOE AL) AL Supplemental Directive 5610.1, Rev. 1, *Packaging and Transportation of Components and Special Assemblies Associated with the Nuclear Weapons Program.*[2] AL Supplemental Directive 5610.1, Rev. 1, Chapter III, Section 2h provides the requirement to prepare a SAR.

The SAR contains the required information for an alternative proposal specified in DOE Order 1540.2, Chapter IV, "Department of Energy Alternative".[3] In addition, the guidance for SARs resulting from the Inert Reservoir Working Group meeting on June 13, 1989,[4] is used to determine the content for the SAR. Chapter IV of the SAR, the proposal description, generally follows the format of Nuclear Regulatory Commission (NRC) Proposed Revision 2 to Regulatory Guide 7.9 [5] to provide document structure familiar to the reader. Chapter IX of the SAR, the quality assurance requirements, follows the format of Revision 1 to NRC Regulatory Guide 7.10.[6]

I.B Overview

The Savannah River Site (SRS) near Aiken, South Carolina, receives reservoirs and reservoir components from the field and reservoir manufacturer. SRS produces filled reservoirs for the weapon component or for the trainer unit. SRS ships the inert type reservoirs in the SR-101 Inert Reservoir Package to the customer.

The SR-101 Inert Reservoir Package can carry a maximum of three compressed gas reservoirs dependent on available space and the design agency reservoir kit requirements. The reservoirs are packaged in a foam-lined cylindrical packing canister inside a cane fiberboard lined stainless steel overpack drum. The packaging assembly is shown in Figure 1.

The gas reservoirs can contain two types of fills; a mixture of non-flammable compressed inert gases and a fill containing a compressed gas mixture that is flammable because it includes hydrogen isotopes. The flammable compressed gas mixture may contain trace amounts of tritium in quantities no greater than a "limited quantity of radioactive material" as specified for tritium in Title 49, Code of Federal Regulations (CFR), Part 173, §173.423.[7] The SR-101 Inert Reservoir Package meets the DOT requirements for shipping a limited quantity of radioactive material. Shipments must be made via public vehicles or aircraft operated by DOE employees or authorized DOE contractor personnel. Aircraft must be for cargo shipments only. Commercial transport is not authorized.

II. ALTERNATIVE TO REGULATIONS

DOE AL Nuclear Explosive Safety Division requires the SR-101 Inert Reservoir Package to meet both DOE Order 5610.1 [1] and AL Supplemental Directive 5610.1, Rev. 1.[2] These orders do not specifically address inert reservoir transportation safety requirements. However, the orders do provide a regulatory mechanism for comparing the level of safety of the SR-101 Inert Reservoir Package to applicable transportation safety requirements. To associate the package to the requirements of AL Supplemental Directive 5610.1, the inert reservoirs are categorized with nuclear components and special assemblies.

DOE Order 5610.1, Paragraph 7(b), requires that "nuclear explosives, nuclear components, and special assemblies must be packaged and transported to provide a level of safety at least comparable to that provided by the packaging and shipment, in accordance with applicable regulations, of other radioactive and explosive material". AL Supplemental Directive 5610.1, Chapter III, restates this requirement for nuclear components and special assemblies. Specifically, the supplemental directive states these items will be shipped in packages that shall achieve a similar or higher level of protection compared to that provided by federally specified transportation requirements for other hazardous, radioactive, and explosive materials.

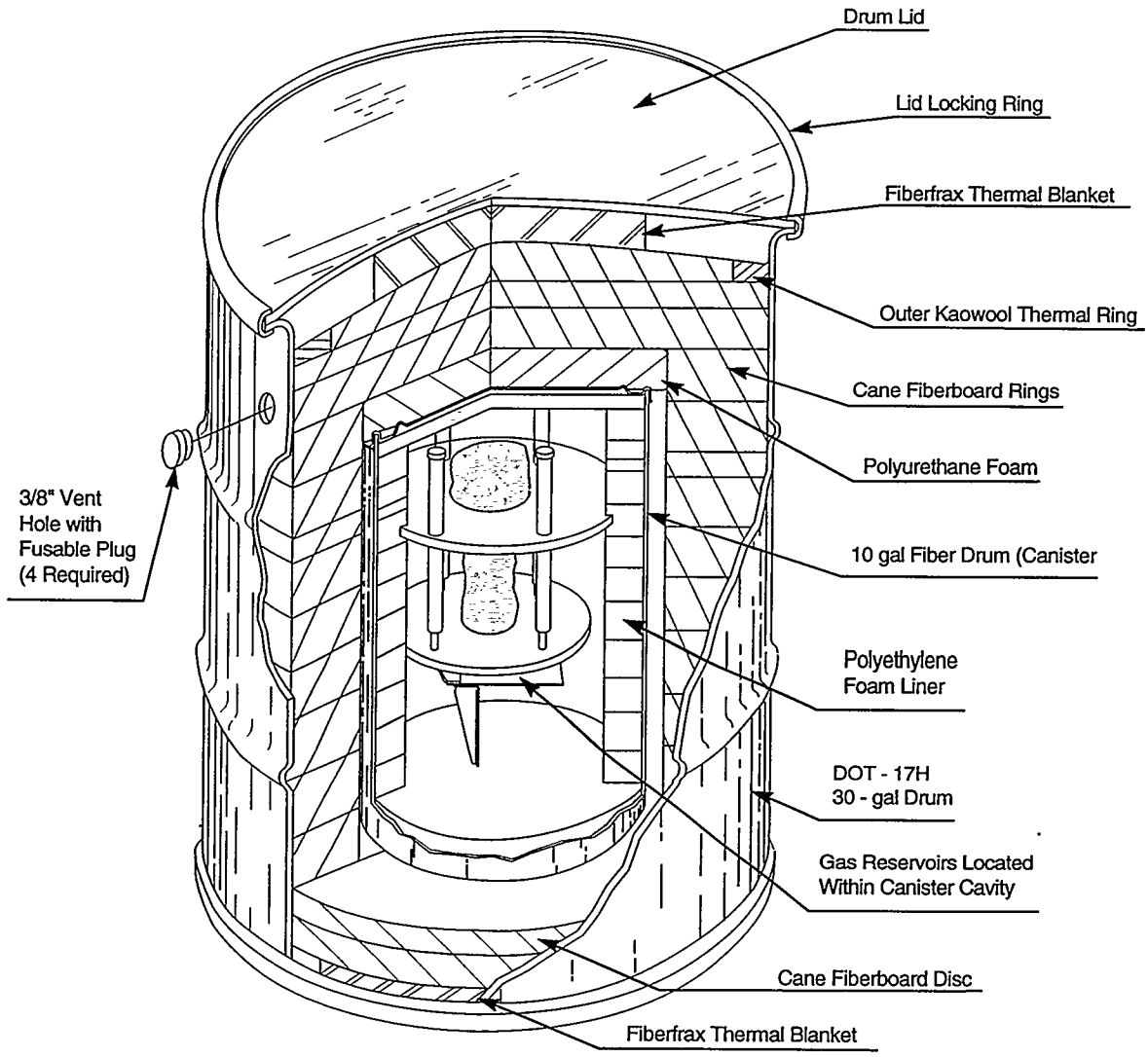


Figure 1. SR-101 Inert Reservoir Package Assembly

The DOT regulations listed in Title 49 CFR, Subchapter C, *Hazardous Materials Regulations,*[7] provide the "established packaging standards" for the compressed gas reservoir fills.

The DOT regulations, specifically 49 CFR §173.301 and §173.302, provide the requirements for compressed gas cylinders. The reservoirs are most like the DOT Specification 39 cylinder, called out as acceptable for use in §173.302. The requirements for the Specification 39 cylinder are provided in §178.65. Specification 39 is a non-reusable (non-refillable) cylinder that can have either cylindrical or spherical geometry and can be made of steel of the same types used to fabricate the reservoirs. However, the reservoirs cannot meet all the requirements of §178.65 for Specification 39 cylinders. In particular, the requirement for pressure relief devices is not met. The reservoirs have no pressure relief capability. Chapter VIII of the SAR provides a point by point comparison of the SR-101 Inert Reservoir Package to the DOT requirements for the Specification 39 cylinder to illustrate the degree of similarity.

This SAR demonstrates that, although the SR-101 Inert Reservoir Package does not meet all the applicable DOT transportation safety requirements, it meets the intent of the requirements. With the degree of protection provided for the reservoirs by the overpack drum assembly, the package provides a level of safety at least equivalent comparable to that provided by DOT regulations. SR-101 packaging and shipment, therefore, complies with DOE Order and AL Supplemental Directive 5610.1, Rev. 1.

III. APPLICANT IDENTIFICATION

The DOE Savannah River Field Office (SR) is the DOE AL Offsite Transportation Authorization (OTA) applicant for the SR-101 Inert Reservoir Package. The applicant contact is the Assistant Manager for National Security, SR or the Director, Tritium Division, SR.

IV. PACKAGE SAFETY EVALUATION

This section contains a description of the SR-101 Inert Reservoir Package, the evaluations of the performance of the package under normal conditions of transport and a hypothetical fire accident condition, and descriptions of the package loading, unloading, maintenance, and testing procedures. The format of the section generally follows the format of NRC Regulatory Guide 7.9.[5] The discussion in this section is the basis to determine that the SR-101 Inert Reservoir Package provides a level of safety at least equivalent to the applicable transportation safety requirements.

IV.A General Information

A brief package description is provided in this section. More information on the packaging material properties is included in the structural and thermal evaluation sections, SAR Sections IV.B and IV.C respectively.

IV.A.1 *Package Description*

The SR-101 Inert Reservoir Package (see Figure 1) consists of one or more compressed gas reservoirs in a foam-lined cylindrical fiber drum called the packing canister, which is placed inside a cane fiberboard-lined stainless steel overpack drum. The cavity within the packing canister is designed to accommodate three reservoir packing configurations as shown in Figure 2. The reservoir, Figure 3, is the containment vessel for the compressed gas. The packing canister and cane fiberboard overpack drum provide protection for the reservoir against impact loads incident to normal transport (i.e., an 8-ft drop) and high heat from a hypothetical fire accident.

IV.A.1.a Packaging

The SR-101 packaging is designed to accommodate reservoirs of different designs and sizes. General reservoir requirements for shipment have been established for all reservoirs shipped in the SR-101 Inert Reservoir Package (see SAR Section IV.B.1.b). Additional descriptive information for the gas reservoir is provided in SAR Sections IV.B and IV.D.

The first of the three reservoir packing configurations, the Type 1 configuration, consists of a reservoir attached to a strongback support. The SP992 assembly in the Type 1 configuration in Figure 2 is an example of a typical strongback. The strongback is designed to hold the reservoir firmly in place and provide support to any fill stems or squib valves attached to the reservoir. The strongbacks are specified by SRS in a "kit definition package" for each reservoir requiring one. The strongback assembly is suspended in the polyethylene foam-lined cavity of the packing canister by imbedding the radial support plate between layers of the polyethylene foam. Protection of the reservoir from loads in the axial direction is provided by the strongback assembly posts and legs, which absorb the load if the assembly contacts the foam discs at the ends of the packing canister (e.g., in the event of an end drop).

Some gas reservoirs are prepacked in strongbacks made of rigid plastic with lockdown clamps and bolts. These assemblies are packed in cardboard boxes with flexible polyurethane foam wrapping used to fill up any voids. The two larger size cardboard boxes fit snugly within the notches cut in the polyethylene foam-lined cavity of the packing canister as depicted in the Type 2 packing configuration in Figure 2.

Some reservoirs, shown in the Type 3 configuration, are placed directly in the packing canister without strongback assemblies. The fill stems on these reservoirs are protected by nylatron caps that are either clamped or screwed to a fill boss or metal caps that are screwed on over the stems as shown in Figure 3. Reservoirs may have squib valves (with shorting clips) attached over the fill stem that provides protection for the stem. Some reservoirs are prepacked in smaller cardboard boxes that require additional packing to fit snugly in the canister. The canister is divided into cells to accommodate more than one reservoir or small box with enclosed reservoir. A separation is provided between the reservoirs or boxes as shown in the Type 3 configuration in Figure 2. The cell dividers are 1/8-inch plywood discs that are imbedded between the layers of the polyethylene foam lining. The number of cells in a canister is only limited by the packing requirements in SAR Section IV.E.1. The cells are packed sequentially by placing a wrapped reservoir or box in the canister cavity, filling the void space with flexible polyurethane foam, and placing a plywood cell divider disc on top to form the cell. This action is repeated until the canister cavity has been filled.

The overpack drum is a 304 stainless steel 30-gallon DOT-17H drum. The drum has four vent holes equally spaced around the drum just below the lid. The vent holes prevent the drum from overpressurizing in a fire. The drum is lined with cane fiberboard that provides impact absorption and thermal insulation. As shown in Figure 1, refractory insulation is placed between the drum lid and the fiberboard and between the drum bottom and fiberboard.

Appendix 1 includes reference drawings for the drum overpack and packing canister.

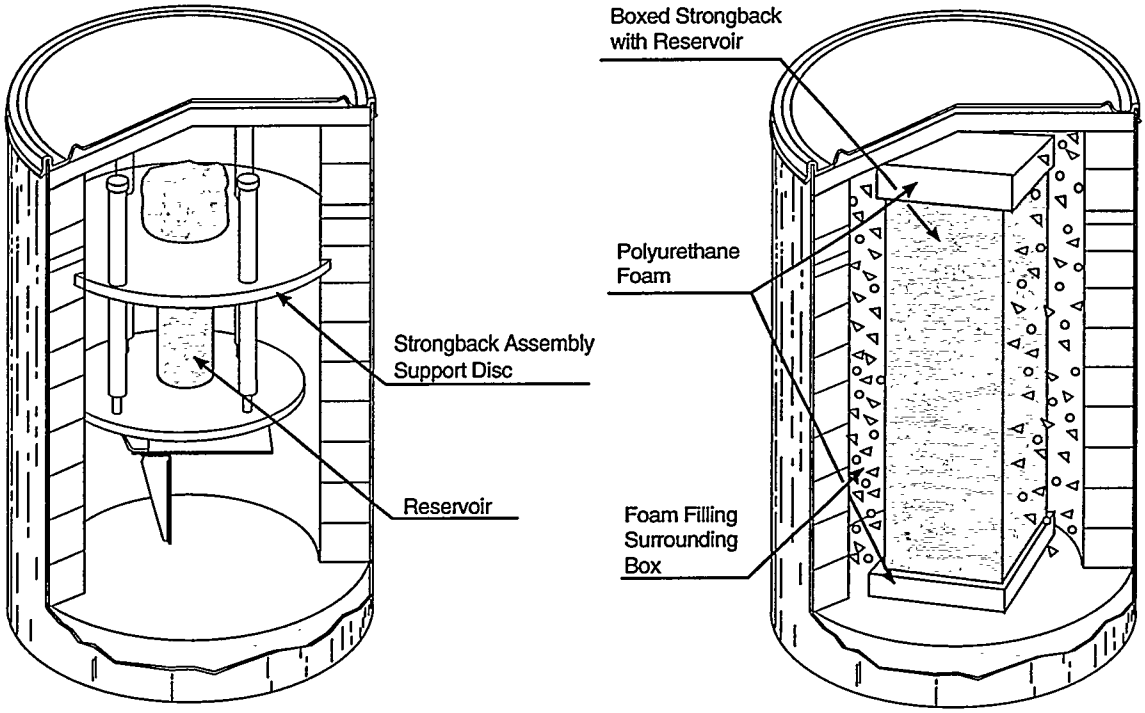
IV.A.1.b Operational Features

The SR-101 Inert Reservoir Package has no active systems required to function during transport. The operational features consist primarily of the package closures. As shown in Figure 1, the package consists of a reservoir (welded containment vessel) in a packing canister that is placed within a steel overpack drum.

Some reservoirs are attached to strongbacks with lockdown clamps and bolts to support and protect the reservoir fill stems.[8] Other reservoirs are foam wrapped and placed in cells within the packing canister. The reservoirs are fixed in the packing canister in the configurations shown in Figure 2. The packing canister lid is held in place by three metal tension clips that snap over the edge of the lid.

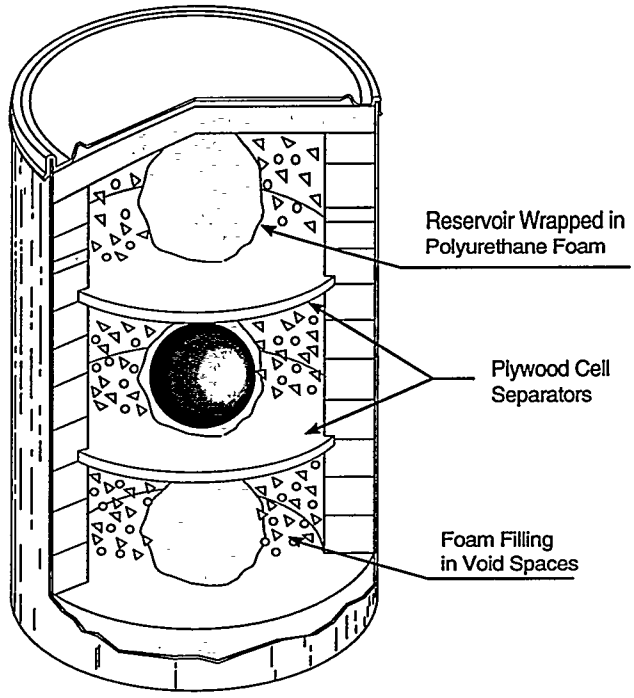
The DOT-17H overpack drum closure consists of a rubber lid gasket, locking ring with reinforced lugs, and closure bolt. The closure bolt is torqued to 45 ± 2 lb-ft. Each cane fiberboard liner assembly is fastened together with threaded rods and screws. The fastening nuts are torqued to 10 ± 2 lb-in. The cane fiberboard top packing assembly is attached to the lower liner assembly with screws torqued to 15 ± 2 lb-in.

The package has no unique lifting attachments and requires no special handling equipment. The package is moved around in preparation for transport either by hand with standard drum handling equipment or on a pallet using a forklift truck.



Type 1 - Typical Strongback (SP992) Configuration

Type 2 - Typical Strongback (Boxed) Configuration

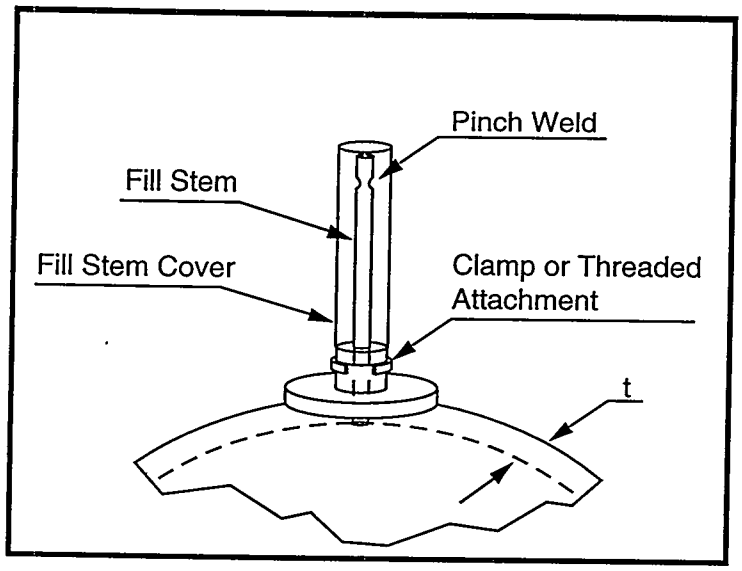


(not to scale)

Type 3 - Typical Cell Configuration

M92G041.01
9/22/92

Figure 2. Reservoir Packing Configurations in the Packing Canister



DETAIL

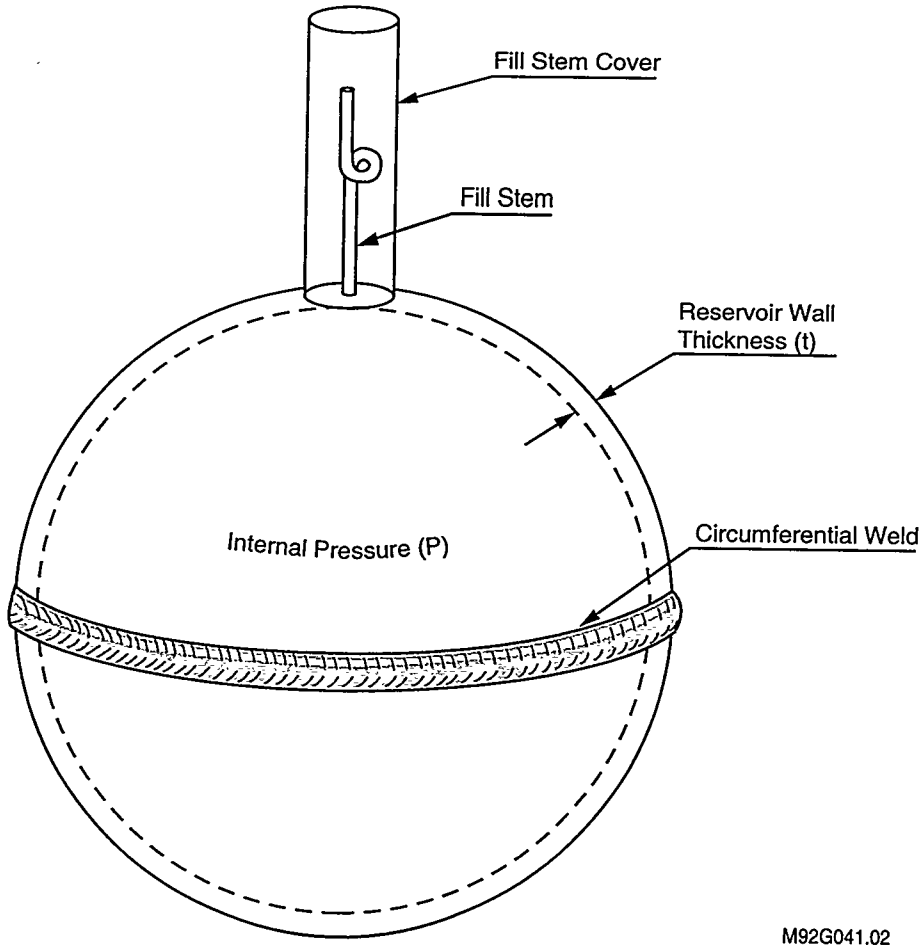


Figure 3. Reservoir

IV.A.1.c Contents of Packaging

Contents of Reservoirs

The reservoir fill may be either:

1. A compressed non-flammable gas. The DOT hazard classification per 49 CFR 172.101 is "nonflammable gas", or

2. A compressed flammable gas that may contain a limited quantity of radioactive material. The DOT hazard classification per 49 CFR 172.101 and 173.2 is "flammable gas".

For the first type fill, a reservoir is filled with non-flammable compressed gases. This fill contains no radioactive material. For the second type fill, a reservoir may be filled with a compressed gas mixture that is flammable because it includes hydrogen isotopes. The flammable compressed gas mixture may contain trace amounts of tritium in quantities that do not exceed the level for limited quantities of radioactive material (20 curies for tritium) as specified in 49 CFR 173.423. Therefore, per §173.421, the package is given an exception from the requirements of 49 CFR 173, Subpart I, *Radioactive Materials*, provided that the package meets certain requirements. The SR-101 Inert Reservoir Package meets these requirements as described in the comparison with the applicable DOT regulations in SAR Section VIII.A.6.

The reservoir fills have no corrosive or reactive chemical characteristics presenting a transportation hazard. If the fills of compressed flammable gas are released in the presence of an ignition source, the gas may burn.

Squibs

Squib valves are attached to some reservoirs that are shipped in the SR-101 Inert Reservoir Package. The squibs contain a small explosive charge that, when fired, drives a cutting edge that shears the fill stem. The explosive in the squib is classified Division 1.4S, categorized as a DOT Class C (minimum hazard) explosive. Actuation of the squib results in a sudden release of the compressed gas contents from the reservoir. Shorting clips are attached to the squibs to prevent a static charge from inadvertently activating the squib. If the hazard from the squib explosive is considered separately from the release of the compressed gas, its effect on the package would be small in comparison with the effect of the compressed gas. The package would easily contain the explosive force generated by detonation of the squib. Therefore, the primary hazard for which the package is designed is the compressed gas. The packaging requirements to transport a Division 1.4S explosive are met by the SR-101 Inert Reservoir Package as described in SAR Section VIII.A.7.

A current listing of reservoirs and squib valves qualified for shipment in the SR-101 is provided in Appendix 4.

IV.B Structural Evaluation

This section describes the SR-101 Inert Reservoir Package design, materials, structural tests, closure, package performance under normal transport conditions, and usage procedures.

IV.B.1 *Structural Design*

The SR-101 Inert Reservoir Package is designed to ensure that the contents of the reservoirs will not be released under normal conditions of transport or a hypothetical fire accident. An unprotected reservoir can fail either by mechanical force causing rupture of the vessel or by heat causing overpressurization and the vessel to burst. The overpack drum, cane fiberboard lining, and foam-lined inner packing canister protect the reservoirs from mechanical impacts and high temperatures. The ability of the packaging to protect the reservoirs from the external environment and structural damage from mechanical loading under normal conditions of transport is discussed in SAR Section IV.B.6. The ability of the packaging to protect the reservoirs from heat under normal conditions of transport and fire accident conditions is discussed in SAR Section IV.C.

IV.B.1.a Discussion

Several different types of reservoirs will be transported in the SR-101 Inert Reservoir Package. They will vary in size and their shape may be either spherical or cylindrical. Several different types of steel may be used. Some reservoirs will have fill tubes extending out from the reservoir body or have squib valves attached.

To accommodate the variety of reservoirs currently in inventory and allow for future reservoir designs, general reservoir requirements for shipment are provided in this SAR. These requirements are provided to ensure that the reservoirs shipped in the SR-101 Inert Reservoir Package meet design standards consistent with the applicable DOT standards or suitable alternate requirements. The reservoir requirements for shipment, together with the standards and specifications for the packaging components, provide the overall set of package design criteria.

IV.B.1.b Design Criteria

The reservoir requirements for shipment are taken from DOT regulations: 49 CFR 173.301, *General Requirements for Shipment of Compressed Gases in Cylinders*; 49 CFR 173.302, *Charging of Cylinders with Non-Liquefied Compressed Gases*; and 49 CFR 178.65, *Specification 39, Non-reusable (non-refillable) Cylinder*, as applicable. Reservoir design criteria have been established to meet the reservoir service requirements. These criteria may exceed the requirements in the applicable DOT regulations. Unique design features of the reservoirs require exceptions to some Specification 39 requirements. In SAR Section VIII.A, the differences between the reservoir and a Specification 39 cylinder are identified and discussed relative to the safety of the package.

DOT 17H drums have been tested under normal conditions of transport as documented in *DOE Evaluation Document for DOT 7A Type A Packaging.*[9] The overpack drum design with cane fiberboard insulation has been extensively tested at hypothetical accident conditions with various size drums and inner containment vessels as part of the Lewallen study.[10] The SR-101 overpack is similar in design to several of the overpacks tested to accident conditions in the Lewallen study. Therefore, the SR-101 overpack design is expected to perform equally well under the same hypothetical accident conditions. Design specifications for the overpack drum include design features recommended by the Lewallen study (i.e., minimum cane fiberboard thickness, vent holes, etc.). Adherence to the design specifications will assure that the overpack performs adequately under the normal and accident transport conditions specified in this SAR.

Reservoir Requirements for Shipment in the SR-101 Inert Reservoir Package

The package user must verify that the reservoirs meet the following requirements:

1. The reservoirs must be of a seamless welded steel construction and of either a cylindrical or spherical geometry [§178.65-2(a)].

2. The reservoir volume must not exceed 75 cubic inches for a flammable gas mixture [limitation on use of Spec. 39 for flammable gas per [§173.302(a)(4)].

3. The reservoir volume must not exceed 277 cubic inches for a non-flammable gas mixture [§178.65-2(b)(2)].

4. The service pressure is equivalent to the pressure in the reservoir at 70°F.

5. The pressure in the reservoir at 130°F shall not exceed $^5/_4$ times the service pressure [§173.301(f)].

6. The reservoir service pressure must not exceed 80% of the test pressure [§178.65-2(c)]. The test pressure cannot be less than the pressure of the contents of the reservoir at 130°F [§178.65-2(d)]. The most limiting of these two requirements for test pressure must be used to establish the correct test pressure at which to evaluate the reservoirs.

7. Burst must not occur at a pressure less than 2.0 times the test pressure [§178.65-11(b)(1)]. The tested reservoirs must not fail in the weld, braze, or attachment point at a pressure less than 2.5 times the test pressure.

8. The temperature at which the reservoir or fill stem will burst must be greater than 230°F. The formulas and methods used for calculating the burst pressure for the reservoirs are provided in Appendix 2.

9.a The reservoirs must be constructed of high-energy-rate forged (HERF) austenitic stainless steel.

9.b The reservoirs must also be constructed of steel conforming to the following requirements [§178.65-5(a)]:

	Ladle Analysis	Check Analysis
Carbon, maximum percent	0.12	0.15
Phosphorus, maximum percent	0.04	0.05
Sulfur, maximum percent	0.05	0.06

10. Reservoirs of non-heat treated welded steel must be of adequately killed deep drawing quality steel [§178.65-5(a)(3)].

11. Welded joints must have strength equal to or greater than the minimum strength of the shell material in the finished cylinder [§178.65-6(b)(7)].

12. The minimum wall thickness must be such that the wall stress at test pressure does not exceed the yield strength of the material of the finished reservoir wall [§178.65-7(a)]. The fill stem wall must also meet this requirement.

13. Calculation of the stress for the cylindrical and spherical reservoirs can be made by the formulas provided in Appendix 2. The formula for the wall stress in a sphere in §178.65-7(c) is specified in Appendix 2. A more conservative formula for the wall stress in a thick wall cylinder is substituted for the §178.65-7(b) formula in Appendix 2.

14. Reservoir openings and attachments are permitted on heads only [§178.65-9(a)].

15. All openings and their reinforcements must be within an imaginary circle, concentric to the axis of the cylinder (or concentric to the center of the hemisphere). The diameter of the circle may not exceed 80% of the outside diameter of the cylinder. The plane of the circle must be parallel to the plane of a circumferential weld of the reservoir cylinder or sphere and normal to the long axis of the cylinder [§178.65-9(b)].

16. Unless the reservoir head has adequate thickness, each opening must be reinforced by a securely attached fitting, boss, pad, collar, or other suitable means [§178.65-9(c)].

Overpack Drum and Packing Canister Design Criteria

1. Strong outside packaging (overpack drum and packing canister) is required to provide protection for the reservoirs and fill tubes against damage and to provide protection for reservoir squib valves against accidental activation [§173.301(k)].

Inner Packing Canister:

2. Specification of the packing canister is as follows:

   Greif Bros. ECONOMY Brand fiber drum (or equivalent), size FD-1 (10 gal.)

   Lid strap: No. 2 nylon attached to stainless steel lugs (See Dwg. R-R4-H-0057)

3. Specification of packing canister foam lining:

   Ethafoam™ M1™ polyethylene foam

4. Specification of flexible foam packing:

   Polyurethane foam, open cell, density: 1 $^1/_2$–2 lb/ft^3

Overpack Drum Fiberboard Insulation:

5. Cane fiberboard, roof insulating board grade, 15–18 lb/ft^3, density per ASTM Spec. C-208-72

6. Minimum insulation thickness: 2 inches, cylinder wall and top and bottom[10]

Steel Drum:

7. General criteria of:

   DOT 49 CFR 178.118 Specification 17H stainless steel drum requirements for a 30-gallon full open head drum

8. Component requirements:

   DOT-17H closure requirements with the exception of an increased requirement for a $^5/_8$-inch SAE grade 2 or better bolt with a 12,900 pound minimum tensile strength and a jam nut

   Reinforcement of forged lugs on the closure ring by additional welding (See Detail A, Dwg. R-R0-H-0004)

9. Vent hole requirements:

   Four $^3/_8$-inch diameter vent holes near the top of the drum equally spaced around the circumference of the drum and capped with $^3/_8$-inch diameter, BP cap plugs

IV.B.2 *Weights and Centers of Gravity*

SR-101 Inert Reservoir Package component weights are listed below:

Component	Weight (lb.)
Reservoir and fixture	25 (maximum)
Packaging (without reservoir and fixture)	105

The package center of gravity is located axially approximately 0.9 inches above the package center for the Type 1

configuration previously tested (SR30J).

Note: The center of gravity will vary somewhat along the center axis depending on the particular reservoir weights and loading arrangements.

IV.B.3 *Mechanical Properties of Materials*

The reservoirs can be made with any type of steel that meets the design criteria in SAR Section IV.B.1.b. The properties of the steels used must allow the reservoir to meet the pressure requirements in the design criteria.

The DOT-17H drum body and closure are made from 304 stainless steel sheet. This drum and similar drum types have been successfully used for many years and have demonstrated no compromising brittle fracture behavior. The fiberboard insulating material is used in many radioactive material packagings in such use has proven to be durable, and provides an excellent thermal and impact barrier. The compression properties of the fiberboard are uniform over the temperature range -40°F to 150°F.[11]

IV.B.4 *General Standards*

The SR-101 Inert Reservoir Package compliance with standards generally applicable with all such packages are described in this section.

IV.B.4.a Tamperproof Feature

A seal wire installed through the 1/8-inch diameter holes in the lid closure ring lugs is the SR-101 Inert Reservoir Package tamperproof feature (See Detail A, Dwg. R-R0-H-0004).

IV.B.4.b Positive Closure

The full removable head DOT-17H drum lid, when properly attached with the locking ring and specified bolt and jam nut, provides the SR-101 Inert Reservoir Package with positive closure. The closure bolt is progressively torqued to 45 ± 2 lb-ft while the closure ring is rapped with a soft-faced hammer.

IV.B.4.c Chemical and Galvanic Reactions

Table 1 indicates all dissimilar contacting materials within the SR-101 Inert Reservoir Package and the material locations within the package. No adverse chemical and galvanic reactions occur.

IV.B.4.d Hydrogen Embrittlement

High-energy-rate forged (HERF) austenitic stainless steel is an acceptable material of construction for inert reservoirs. Tensile test data show that HERF alloys are more resistant to hydrogen damage than either annealed or cold-worked alloys. Yield and tensile strengths are higher in the HERF alloys. Therefore, on the basis of retained ductility for a given strength level, the HERF alloys are superior to annealed alloys.[12]

IV.B.5 *Lifting and Tiedown Standards*

The SR-101 Inert Reservoir Package lifting and tiedown devices and methods are described in this section. Conventional drum handling techniques controlled by operating procedures are generally used.

Table 1. Dissimilar Contacting Materials in the SR-101 Inert Reservoir Package

	Material Number																	
Material / Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Stainless steel / DOT-17H drum	♦	×	×		×	×	×											
2 Neoprene gasket / Drum lid	×	♦																
3 Kaowool M board / Top ring	×		♦	×	×		×											
4 Cerablanket / Bolt hole plug			×	♦			×	×										
5 Plastic vent plug / Drum side	×		×		♦													
6 Fiberfrax® insul. / Under drum lid	×					♦	×											
7 Cane fiberboard insul. / In drum	×		×	×		×	♦	×	×									
8 St. steel / Screws, washers, rods, nuts, etc.				×			×	♦										
9 Fiberboard / Inner canister							×		♦	×								
10 Polyethylene foam / In canister									×	♦	×	×	×		×			
11 Plywood / Cell divider discs										×	♦	×						
12 Polyurethane foam / Packing										×	×	♦			×	×	×	×
13 Epoxy finish / SP992 strongback										×			♦	×				
14 Neoprene protective ring / SP992													×	♦				×
15 Cardboard / Packing box										×		×			♦	×		
16 Nylon / Nylon strongback												×			×	♦		×
17 Plastic / Reservoir cover bag												×					♦	×
18 Steel / Reservoir												×		×		×	×	♦

IV.B.5.a Lifting Devices

The SR-101 Inert Reservoir Package has no unique external lifting devices other than the features of a standard DOT-17H drum. Normally the package is moved within the facility by rolling it on the lower chime of the overpack drum. Standard drum handling equipment is used when available. For longer inter-facility moves, the package is manually maneuvered onto pallets and moved with a forklift truck. The packages are not stacked for forklift movements.

IV.B.5.b Tiedown Devices

The SR-101 Inert Reservoir Package has no unique external tiedown devices other than the features of a standard DOT-17H drum. In courier truck shipments and air shipments, the packages must remain upright and be restrained in all axes in accordance with documented and controlled procedures.

IV.B.6 *Normal Conditions of Transport*

Conditions normally incident to transportation represent air and ground transport conditions likely to be encountered by the SR-101 Inert Reservoir Package. This section demonstrates that the package integrity is not diminished under normal conditions of transport. The applicable DOT requirement §173.24, *Standard Requirements for All Packages*, states that the package shall be designed and constructed such that under conditions normally incident to transportation there will be no significant release of the hazardous materials to the environment and the effectiveness of the packaging will not be substantially reduced. The performance of the package is evaluated against a set of conditions that could reasonably be expected to occur during transport of the package. This includes consideration of an 8-ft drop that might occur during loading or unloading of the package from an aircraft cargo bay.

IV.B.6.a Heat

The SR-101 Inert Reservoir Package is not adversely affected by the temperatures it experiences under the normal "heat" condition of transport as defined in the NRC regulations for packaging and transportation of radioactive material, 10 CFR 71.71.[13] The maximum temperature that the reservoir may reach will not exceed 124°F. The reservoir wall stress at the pressure corresponding to 124°F will not exceed yield. The steel overpack drum and cane fiberboard will experience temperatures greater than 124°F. The overpacking is similar to many approved radioactive materials packagings, notably the DOT Specification 6M, all of which have been shown to function satisfactorily at temperatures above 124°F. See SAR Section IV.C.2 and Appendix 3 for a detailed discussion of the performance of the package under the heat condition.

IV.B.6.b Cold

A -40°F ambient temperature will not adversely affect the SR-101 Inert Reservoir Package. Reservoir design agencies impose a -65°F lower operating temperature requirement on the reservoir.[14] The overpacking is adequate in cold environments, as demonstrated by favorable shipping experience with many similar radioactive material overpacks. The cane fiberboard insulation is unaffected by a low temperature of -40°F.[11] Experience has shown that brittle fracture in the stainless steel overpack drum is not a problem.[15]

IV.B.6.c Reduced External Pressure

A 3.5 psia external pressure is insignificant relative to the reservoir fill pressure. Weapon environment use demands that the reservoir be able to withstand rapid external pressure and temperature fluctuations. Four vent holes on the side of the overpack drum near the lid ensure the overpacking reaches equilibrium with ambient pressures. If the drum vent holes remain sealed, the DOT-17H drum is capable of withstanding 15 psig of internal pressure without rupture as specified in 49 CFR 178.118.

IV.B.6.d Increased External Pressure

An external pressure of 20 psia (5.3 psig) is insignificant relative to both the reservoir and the SR-101 overpack drum for the reasons stated in SAR Section VI.B.6.c above.

IV.B.6.e Vibration - Truck and Air Transport

The packing configurations for the SR-101 Inert Reservoir Package provide vibration dampening for the reservoir. The reservoir packing canister is lined with polyethylene foam. The Type 1 strongback configuration has the reservoir attached to a strongback that is imbedded in the foam liner. The Type 2 boxed reservoir configuration has various size cardboard boxes packed within the foam-lined canister with any void spaces filled with flexible polyurethane foam. The Type 3 cell configuration has reservoirs wrapped in flexible foam and placed in the polyethylene foam lined canister with additional foam filling the voids. The cells are separated by plywood discs imbedded in the foam-liner of the canister. These packing features will reduce the level of transportation vibration transmitted through the packaging to the reservoir. The only feature of the reservoirs that may be susceptible to transportation vibration would be a long unsupported fill stems. However, all long fill stems are supported by clamping to strongbacks. Stem fatigue from transportation induced vibration is not a concern based on an evaluation of the W84 MC3430 reservoir, considered to be the most vulnerable to stem fatigue.[16]

The successful DOE reservoir packaging transport experience to date also indicates that the reservoirs are not prone to vibration damage. The SR-101 Inert Reservoir Package mitigates the impact of transport vibration at least as well as the previously used packaging.

IV.B.6.f Water Spray

The water spray will cause no damage to the stainless steel overpack drum. The overpack drum closure is sealed with a rubber gasket and the vent holes are plugged with plastic caps. Water from a water spray condition will not enter the package and therefore, will not cause damage to the package.

IV.B.6.g Free Drop

A free drop of 8 ft onto an essentially unyielding surface is a specified normal condition of transport for the SR-101 Inert Reservoir Package. A distance of 8 ft represents the greatest possible drop height that would normally be encountered during transport of the package. SRS had previously performed two 8 ft-drop tests on the SR30J package,[17] which has the same packaging design as the SR-101 Inert Reservoir Package. The only difference in the packages is that the SR30J carries a single reservoir type in a strongback, while the SR-101 Inert Reservoir Package may carry a variety of reservoir types including the SR30J reservoir. The SR-101 package would also weigh 5% more (5.7 lbs.) than the SR30J package when carrying the SR30J reservoir. However, since the additional weight is in the packing materials and not the reservoir itself, the added weight will have no effect on the survivability of the SR30J reservoir. The other reservoir types carried in the SR-101 package would result in smaller package weights and would sustain less damage when dropped.

All the reservoirs carried in the SR-101 Inert Reservoir Package are cushioned by the same amount of polyethylene foam as in the SR30J. The reservoir types prepackaged in boxes or plastic bags are further cushioned by flexible polyurethane foam wrapping to ensure that they are well protected when subjected to an 8-ft drop. The SR-101 Inert Reservoir Package can be shown to meet the 8-ft drop condition by comparison with the SR30J package drop tests due to the similarity of the two packages.

The first SR30J drop test demonstrated packaging integrity. Since the SR-101 is essentially an identical package, it too will act similarly. When dropped 8 feet onto a 6-inch thick concrete reinforced steel plate with the packaging center of gravity over the impacted closure bolt, the closure region indented 7/16 of an inch. The drum did not rebound and the drum lid did not separate from the drum body. The package was easily disassembled following the test. Lead shot in a polyethylene bottle placed inside the inner foam padded packing canister simulated the reservoir and shipping fixture weights. The added packing weight (5.7 lbs.) would slightly increase the damage reported for

the SR30J drum. This is not considered to be a problem based on the small amount of damage the SR30J experienced, which is further supported by the drum test results documented in Reference 9.

The second drop test of SR30J demonstrated that the package can withstand an 8-ft drop with no reservoir damage.[17] An actual reservoir, constrained by a strongback, was assembled in the previously dropped packaging. The SR30J was dropped on its side, angled slightly to cause a "slap down". The chosen drop orientation tested the reservoir restraint most severely. Also, any movement of the fill stem relative to the reservoir body would be most evident. The drop did not deform the reservoir fill stem or cause the reservoir to move in its fixture. There were no visible changes to the fixture or reservoir. The fiber canister and polyethylene liner effectively cushioned the strongback during the impact. The slap down caused noticeable flattening on the bottom edge of the drum. The top closure region, although further indented, was easily disassembled.

The reservoir packing configuration tested in the SR30J package is considered to be the more vulnerable configuration of the types to be shipped in the SR-101 Inert Reservoir Package. The individually packed reservoirs (without strongbacks) have either squib valves or stem covers protecting the fill stems. These reservoirs are adequately contained within their individual cells by the foam cushioning and would be the least susceptible to damage in a drop test. The reservoirs packed within a strongback are also adequately contained within the packing canister. However, the strongback supported reservoirs were considered to be more vulnerable to an 8-ft drop than the individually packed reservoirs. Of the strongback configurations, the one used in the SR30J package was judged to have the least amount of support within the packing canister. The SR30J strongback is only locally constrained within the canister liner and would penetrate the liner on impact because of the design of the support plates, as demonstrated in the second SR30J drop test.[17] The other strongback configurations are totally constrained with foam wrap and would better absorb the impact. Because the SR30J strongback configuration adequately passed the 8-ft drop tests, it can be safely assumed that the remaining packing configurations would also survive the test.

IV.B.6.h Compression

Tests performed on a similar 30-gallon DOT-17H drum show that the SR-101 package can support a 2700 lb static load.[9]

IV.B.6.i Penetration

Several penetration tests have been performed on similar drum packaging[9] using a 1-1/4-inch diameter 13.2-lb steel rod resulting in only minor damage to the metal drum and no rupture of its metal surface. By comparison, the SR-101 stainless steel overpack drum will provide the same degree of protection against impacting objects.

IV.B.6.j Other Prototype Testing

The SR-101 overpack drum is similar to many existing drum-type radioactive materials overpack drums. Prototype test results for these are readily available, notably, the comprehensive normal condition test results reported in *DOE Evaluation Document for DOT 7A Type A Packagings.*[9]

IV.C Thermal Evaluation

The SR-101 Inert Reservoir Package is required by DOT hazardous material shipment regulations (49 CFR 173.24) to contain its contents and maintain its effectiveness under conditions normally incident to transport. The selected maximum normal heat condition for the package is the heat condition specified in 10 CFR 71.71(c)(1)[13] In addition, the SR-101 package performance is evaluated for a hypothetical fire accident. Specification 39 compressed gas cylinder is required to have a pressure release device system per §173.34(d). The system is required to prevent rupture of the cylinder when subjected to a fire test conducted in accordance with Compressed Gas Association (CGA) Pamphlet C-14. The fire test requires the fire temperatures to reach 1200°F in 5 minutes and for the fire to continue at this temperature for an additional 15 minutes after actuating the relief device. The reservoirs do not have pressure relief devices and could reach burst pressure under these fire conditions. To address this concern the overpack drum has been designed to protect the reservoirs from a "safety equivalent" thermal accident. The burst

situation is prevented by the thermal insulating capability of the SR-101 package. The 10 CFR 71.73 hypothetical accident fire test conditions are considered to be reasonably conservative requirements for this package to meet to adequately protect against reservoir burst from elevated temperatures.[13]

IV.C.1 *Discussion*

The thermal design features of the SR-101 Inert Reservoir Package include the 30-gallon DOT-17H overpack drum and cane fiberboard lining. The steel overpack drum protects the cane fiberboard from weathering and impact, and limits the amount of oxygen that reaches the fiberboard to prevent it from burning in a fire. The cane fiberboard provides impact and thermal protection for the packing canister.

The heat from a fire will cause the cane fiberboard to decompose, producing combustible gases. The gases are vented through holes in the overpack drum. The vent holes are sized and spaced in accordance with the design recommendations of the Lewallen study.[10] The vent holes are equally spaced around the circumference of the drum just under the curl so that no matter what orientation the package is in, they all can't be blocked. This orientation of the vent holes also reduces the likelihood of air convection currents occurring in the drum following a fire. A ring of Kaowool™ M Board ceramic fiber is located directly inside the vent holes to prevent direct contact between the cane fiberboard and the external environment. Both the spacing of the vent holes and the placement of the ceramic fiber help prevent smoldering or continued burning of the cane fiberboard following exposure to a fire. The decomposition of the cane fiberboard results in charring of the fiberboard from the outside inward. The degree of charring is dependent on the temperature of the fire and its duration. For a 1475°F fire of 30 minutes duration, charring would not extend through the thickness of the fiberboard and the temperature of the packing canister will not exceed 230°F.

IV.C.2 *Thermal Evaluation for Normal Conditions of Transport*

IV.C.2.a Thermal Model

A thermal model of the SR-101 Inert Reservoir Package was developed to calculate the temperatures in the package for the normal condition of transport with insolation. The calculations were made using the P/Thermal software code developed by the PDA Corporation. A two-dimensional axisymmetric model was developed that included the cane fiberboard, the fiberboard packing canister, the polyethylene foam canister liner, and a steel inner container representing the reservoir. Details of the model and the results of the analysis are provided in Appendix 3.

The normal heat condition as specified in 10 CFR 71.71(c)(1) is applied to the model. This condition consists of an ambient temperature of 100°F in still air, and insolation values according to the following table:

Insolation Data

Form and location of surface:	Total insolation for a 12-hour period (g cal/ cm^2):
Flat surfaces transported horizontally:	
Base	None
Other surfaces	800
Flat surfaces not transported horizontally	200
Curved surfaces	400

IV.C.2.b Maximum Temperatures

The normal condition of transport thermal analysis was performed on two configurations of the SR-101 model. The first model assumed the minimum amount of reservoir mass (highest reservoir temperatures), and the second model assumed a larger amount of reservoir mass (greater than the SR30J). The results from the two models were evaluated

to determine the maximum temperatures developed in the SR-101 during normal conditions of transport with insolation heating.

The results of the analyses determined that the maximum temperatures developed in the SR-101 are 123.7°F for the reservoirs and 222.1°F for the cane fiberboard (see Appendix 3). The maximum operating temperature that the reservoirs can withstand is 446°F. This is the temperature that will cause the squib valve to detonate. For the cane fiberboard insulation, fiberboard canister, and polyethylene, the maximum operating temperatures are 280°F, 200°F, and 160°F respectively. All of the SR-101 components were determined to operate well within their allowable temperatures for the normal operating conditions with insolation.

IV.C.2.c Minimum Temperatures

The "cold" normal condition of transport is an ambient temperature of -40°F in still air and shade. As discussed in SAR Section IV.B.6.b, a -40°F ambient temperature environment will not adversely affect the SR-101 Inert Reservoir Package. The reservoirs have a -65°F lower operating temperature requirement[14]. The cane fiberboard insulation is unaffected by low temperatures.[11] The steel reservoirs and stainless steel overpack drum are not affected by a temperature of -40°F.

IV.C.2.d Maximum Internal Pressures

The reservoir is filled with compressed gas to a pressure, $P_{initial}$, at an ambient temperature of 70°F. As discussed in SAR Section IV.C.2.b above, the reservoir may reach a maximum temperature of 124°F under the normal heat condition. Under this condition, the pressure in the reservoir will increase by a factor of 1.10 determined by the following expression

$$P_{final} = P_{initial}\frac{(124+460)}{(70+460)} = P_{initial}(1.10)$$

This increase in the internal pressure results in a pressure that is below the reservoir test pressure.

The overpack drum is loaded under atmospheric conditions and is initially at 14.7 psi at 70°F. If it is assumed that the vent hole plugs and the gasket on the drum lid are airtight, then the drum can pressurize as the temperature of the air inside rises under the heat condition. The increase in pressure is determined by the expression

$$P_{drum} = 14.7\ \text{psia}\frac{(171+460)}{(70+460)} = 17.5\ \text{psia}$$
$$= 2.80\ \text{psig}$$

where 171°F is the average temperature within the drum packing.

A small pressure increase of ~2.8 psig will not result in failure of the overpack drum or damage the reservoirs. The DOT-17H drum is hydrostatic pressure tested to 15 psig without leakage.

IV.C.2.e Maximum Thermal Stresses

The thermal stresses in the components of the SR-101 package are a function of the temperature gradient in the materials (i.e., the wall of the reservoir). No significant temperature gradients occur in the reservoir or the overpack drum under the thermal environment imposed by the normal conditions of transport. Therefore, essentially no thermal stresses develop in the reservoir or the overpack drum.

IV.C.2.f Package Thermal Performance for Normal Conditions of Transport

From the discussion in the preceding sections, it can be concluded that the package performs adequately from a thermal standpoint under the normal conditions of transport.

IV.C.3 *Hypothetical Accident Thermal Evaluation*

IV.C.3.a Thermal Model

Extensive testing of packages with design features similar to the SR-101 Inert Reservoir Package has established a good understanding of their thermal performance.[10] The thermal testing was done at the hypothetical accident conditions for Type B shipments of radioactive material corresponding to a fire at 1475°F for 30 minutes per 10 CFR 71.73(c)(3). The fire tests, conducted in a gas-fired heat-treating oven, were done on prototypical packaging configurations similar to the SR-101. A 30-gallon package, the same size as the SR-101, was tested. The containment vessel in the prototype, like the reservoirs, had no internal heat generation.

IV.C.3.b Package Conditions and Environment

The packages tested in the Lewallen study were subjected to side, top corner, and bottom drops of 30 ft and puncture before they were placed in the furnace for the simulated fire test. The damage to the overpack drums and Celotex® fiberboard insulation was negligible. Results of the fire tests showed that the damage sustained prior to the tests did not affect the thermal performance of the fiberboard insulation. The SR-101 Inert Reservoir Package is of similar design and would be expected to sustain a similar amount of damage under these tests. However, the package is not required to withstand a 30-ft drop or puncture test and would suffer less damage from an 8-ft drop. A similar type package, the SR30J, was dropped 8 ft with minimal damage to the drum and cane fiberboard insulation. Therefore, it is expected that any damage to the package before the hypothetical fire will not significantly affect the thermal performance of the package in the fire.

IV.C.3.c Package Temperatures

The Lewallen report contains general specifications for drum and cane fiberboard insulation overpacks.[10] The minimum thickness of insulation specified for a 30-gallon drum is 2 inches on the side and 2.5 inches on the ends. A minimum of 2 inches of cane fiberboard insulation is recommended to prevent temperatures greater than 230°F at the inner surface. The 230°F temperature is due to the outgassing of the cane fiberboard material and would remain relatively constant for thicknesses greater than 2 inches. The temperature would only exceed 230°F when the char extended through to the inner wall of the cane fiberboard.

The SR-101 Inert Reservoir Package has a minimum cane fiberboard thickness on the sides of the overpack of 2.4 inches and a top and bottom thickness of 3 inches. This provides ~1/2-inch margin in the package design over the minimum 2-inch requirement. With this margin, it is expected that a somewhat higher temperature or longer duration fire could be tolerated without exceeding 230°F at the inner surface of the fiberboard insulation. The reservoir will reach a maximum temperature somewhat lower than 230°F due to the additional thickness of polyethylene foam and flexible polyurethane foam within the packing canister. Therefore, it is conservative to use 230°F for the maximum reservoir temperature.

IV.C.3.d Maximum Internal Pressures

The reservoir is filled with compressed gas to a pressure, $P_{initial}$, at an ambient temperature of 70°F. As discussed in Section IV.C.3.c above, the reservoir is conservatively assumed to reach a temperature of 230°F under the fire accident condition. Under this condition, the pressure in the reservoir will increase by a factor of 1.30 determined by the following expression

$$P_{final} = P_{initial}\frac{(230+460)}{(70+460)} = P_{initial}(1.30)$$

This increase in the internal pressure results in a pressure that is significantly below the reservoir burst pressure.

During the hypothetical fire accident, the plastic vent hole plugs on the overpack drum will melt. Steam and combustible gases generated by heating and the resulting decomposition of the cane fiberboard are vented through the open vent holes. This effectively relieves any pressure inside the overpack drum.

Some reservoirs will be shipped with squib valves attached. The squib valves are designed to release the contents of the reservoir when actuated by a charge. The charge, a small 1.4S explosive, is contained within the squib actuator. The charge is stable and will not actuate the squib at temperatures below 446°F. The squib will not be exposed to temperatures above 230°F and therefore, the overpack drum will not experience a sudden overpressurization condition from a temperature induced actuation of a squib valve.

IV.C.3.e Maximum Thermal Stresses

Because of the high insulating capacity of the package, the reservoir does not undergo a rapid change in temperature during the fire. The maximum temperature that the reservoir may reach, 230°F, is significantly below the external fire temperature of 1475°F. Because only small temperature gradients may occur in the reservoir during a hypothetical fire, there will be no significant thermal stresses in the reservoir.

The overpack drum is exposed directly to fire temperature and undergoes a rapid increase in temperature. Due to the thin wall of the drum (~.05 inches) and the presence of the insulation at the inside of the wall, significant temperature gradients will not occur in the drum wall. Therefore, significant thermal stresses resulting from temperature gradients are not expected in the drum. The drum is free to expand as it is heated and no stresses are generated in the drum from the thermal expansion of other packaging materials.

IV.C.3.f Package Performance for Hypothetical Accident Conditions

From the discussion in the preceding sections, it can be concluded that the reservoir is adequately protected by the insulated overpack drum when subjected to a hypothetical fire accident as specified in 10 CFR 71.73.

IV.D Containment

A sudden release or burst of a reservoir may cause a rupture of the overpack drum, possibly causing injury to nearby personnel. The SR-101 packaging protects the reservoirs from damage, thereby preventing a release of their contents under normal conditions of transport or during a transportation fire accident. The compressed gases contained in the reservoir are not a toxic or radioactive hazard if released. Therefore, the containment requirements provided in the transportation regulations for radioactive material are not applicable. The reservoirs do have stringent containment requirements based on weapon needs. This section describes the reservoir containment and containment criteria.

IV.D.1 *Containment Boundary*

The reservoir and fill tube extension is the containment boundary for the SR-101 Inert Reservoir package.

IV.D.1.a Containment Vessel

The reservoirs are spherical and cylindrical vessels of welded HERF high-yield strength austenitic stainless steel with a minimum yield of 50 ksi. A steel fill tube stem and a steel fill fitting are welded to the reservoir. A hole through the integral lug on one end of the reservoir leads to the stem. A pinch weld closes the stem. Reservoir finishing including fill and dimensional and weld finish checks is per SRS written procedures.

IV.D.1.b Containment Penetrations

There are no containment penetrations. The hole penetrating through one of the reservoir lugs is capped by the fill tube stem, which comprises an integral part of the containment vessel.

IV.D.1.c Seals and Welds

The reservoir body welds are semi-automatic gas tungsten arc (GTA) welds. These welds are machined to shape and then radiographed. The fill stem is GTA welded to the fill fitting, which in turn is GTA welded to the drilled reservoir body. Radiography ensures 100% penetration on the fill fitting weld and adequate material thickness. The stem pinch welding operation is performed following approved SRS procedures. After dimensional inspection, the pinch weld is radiographically inspected per SRS procedure. Since the reservoir has no penetrations, leakage of seals is not applicable.

IV.D.1.d Closure

As noted in SAR Section IV.D.1.c, SRS performs full radiography and inspects the dimensions of the pinch weld.

IV.D.2 *Containment Requirements for Normal Transport*

This section defines the containment criteria established for the reservoir. These criteria are based on weapons use and are more stringent than if similar non-weapon use contents were being shipped.

IV.D.2.a Pressurization of Containment Vessel

The contents of the reservoir are in gaseous form. The pressure in the reservoir will increase if the temperature of the gas increases above the fill temperature. The maximum temperature of the reservoir under the normal "heat" condition of transport will be less than 150°F as discussed in SAR Section IV.C.2.b. At this temperature the reservoir could experience an internal pressure increase by a factor of 1.15 (an 15% increase) over the pressure of the contents at 70°F (see SAR Section IV.C.2.d for details). This pressure increase is well below the test pressure for the reservoirs.

IV.D.2.b Containment Criterion

The leakage criteria established by the SRS Defense Programs Division for leak testing the filled reservoirs are sufficient criteria for shipment of reservoirs from SRS. A reservoir with a leakage rate greater than the procedural limit established by the SRS Defense Programs Division for that reservoir type is rejected. These leakage rates are expected to remain unchanged for the reservoirs under the normal conditions of transport and are sufficiently low to be of no hazard. Reservoirs being shipped following service or storage in the field must be visually inspected for damage or altered appearance and bubble tested to verify that they are not leaking prior to placement in the SR-101 Inert Reservoir Package.

IV.D.3 *Containment Requirements for the Fire Accident Condition*

IV.D.3.a Pressurization of Containment Vessel

Under hypothetical fire conditions, the reservoir could experience an internal pressure increase by a factor of 1.30 (a 30% increase) over the pressure of the contents at 70°F. This pressure increase is well below the burst pressure for the reservoirs (see SAR Section IV.C.3.d for details).

IV.D.3.b Containment Criterion

The welded steel reservoir will perform to the same containment criteria under the fire accident condition as stated for the normal conditions of transport in SAR Section IV.D.2.b.

IV.D.4 *Special Requirements*

The SR-101 Inert Reservoir Package has no special containment requirements.

IV.E Operating Procedures

This section summarizes the requirements imposed on the user of the SR-101 Inert Reservoir Package. Adherence to the procedural requirements in this section helps assure that the loading, shipping, and receiving activities at each facility are conducted in a manner that will not compromise the performance of the package. Packaging users shall conduct loading operations using approved written procedures discussed in Chapter IX. The receiver organization shall perform unloading operations and preparations for empty packaging return in accordance with written procedures developed and controlled by the receiver organization. The receiver organization procedures shall be consistent with the procedures used by SRS. SRS shall perform any activities (i.e., storage, inspection, and maintenance) following receipt of empty packagings in accordance with written procedures.

IV.E.1 *Procedures for Loading Packaging*

The reservoirs to be shipped in the SR-101 Inert Reservoir Package may be attached to strongback assemblies, prepackaged in cardboard boxes, or individually wrapped in plastic. All reservoir fill stem tubes must be adequately supported in a strongback assembly or protected by one of the following: an attached squib valve, a nylatron cap that is clamped on or screwed on, or a metal cap that is screwed on over the stem. All reservoirs with electric squib valves attached must have shorting clips installed or other static electricity protection to prevent accidental discharge. All reservoirs shipped in the package must be packed in a 10-gallon fiber canister as specified in Section IV.B.1.b. The canisters are than packed in the cane fiberboard lined overpack drum. A summary of the package loading requirements is provided below.

Canister Packing Requirements

Type 1 Packing Configuration:

1. Reservoirs attached to the SP992 strongback assembly (same configuration as shipped in the SR-30J package) are packed in the canister according to the SR30J procedure.

2. The packing canister is prepared to receive the SP992 strongback assembly by assembling the foam liner to the height indicated for holding the strongback assembly, as depicted on Dwg. R-R4-H-0057 (see Item 1 of the assembly drawing).

3. The strongback assembly is set in the reservoir packing canister by positioning the strongback support disc on the foam liner at this location.

   Note: The strongback is suspended within the canister cavity in this manner with its weight supported by the polyethylene foam rings that form the cavity liner wall up to the ring the support disk rests on.

4. The remaining two foam rings are placed on top of the strongback support disk as depicted on Dwg. R-R4-H-0057.

5. The top solid foam disc is placed on top of the assembly of foam rings (see Item 2 of the assembly Dwg. R-R4-H-0057).

6. The lid is placed on the canister and fastened securely with the three lid clamps.

Type 2 Packing Configuration:

Large Cardboard Boxes of Reservoirs

1. The notched polyethylene foam liner is sized to fit the two larger size cardboard boxes of reservoirs.

2. A minimum of 1 inch of flexible polyurethane foam is placed in the bottom of the foam-lined canister cavity before loading a box.

3. The box is inserted in the canister and another layer of flexible polyurethane foam is placed on top of the box to fill up the void space between the top of the box and the top foam liner disc (see Item 2 on assembly Dwg. R-R4-H-0057).

4. The top foam liner disc is set in place.

   Note: The top disc should fit snugly and be in contact with the flexible foam packing.

   Caution: Do not overpack the canister with foam such that it must be compressed to force the lid on the canister.

5. The lid is placed on the canister and fastened securely with the three lid clamps.

Small Cardboard Boxes of Reservoirs

1. Smaller cardboard boxes of reservoirs that are shipped one per package are packed in the foam lined canister cavity in a similar manner to the large boxes.

   Note: Shipments of more than one of the smaller boxes must be made using the Type 3 packing configuration described below.

2. A minimum of 1 inch of flexible polyurethane foam is placed in the bottom of the foam lined canister cavity before loading a box.

   Note: The smaller boxes require more flexible polyurethane foam packing to ensure that movement within the canister cavity is minimized during transport. The best packing configuration is obtained when the flexible polyurethane foam is used to position the box near the center of the canister cavity, an equal distance between the top and bottom.

3. The top foam liner disc is set in place.

   Note: The top disc should fit snugly and be in contact with the flexible foam packing.

   Caution: Do not overpack the canister with foam such that it must be compressed to force the lid on the canister.

4. The lid is placed on the canister and fastened securely with the three lid clamps.

Type 3 Packing Configuration:

1. Individual reservoirs in plastic bags (without strongbacks) or reservoirs prepacked in cardboard boxes (in cases where more than one box is shipped per canister) are packed in cells constructed within the canister cavity.

2. The cells are constructed with 1/8-inch thick plywood discs that are imbedded between layers of foam liner.

The maximum number of cells is limited to three due to the size of the canister cavity and the minimum thickness of flexible foam packing required around the individual reservoir or box.

3. Each reservoir is wrapped in flexible foam to a minimum thickness of 1 inch. Each box is either wrapped in a minimum of 1 inch of flexible foam or is placed on a minimum of 1 inch of foam in the cell.

4. The wrapped reservoir or small box is placed in the canister cavity and the remaining void volume is filled with additional flexible foam up to the level where the plywood cell divider disc is to be installed (see Items 13 on assembly Dwg. R-R4-H-0057).

Note: In all cases the cell must be large enough to allow a minimum of 1 inch of flexible foam above an individual reservoir or box. The correct fill level of foam is achieved when the plywood separator disc rests 1/4-inch above its imbedded position without compression applied.

5. The next cell is constructed on top of the plywood disc in the same manner as the first.

6. After all of the cells have been assembled, the top polyethylene foam liner disc is installed and the canister lid is fastened securely with three lid clips.

Caution: Do not overpack the canister with foam such that it must be compressed to force the lid on the canister.

Note: For packing canisters containing reservoirs with residual radioactivity (limited quantity), the outside of the canister must be marked "Radioactive" in accordance with 49 CFR 173.421(d).

Overpack Drum Loading Requirements

1. The fiberboard liner assembly (sized to fit the reservoir packing canister) is fastened together with screws and rods as shown on Dwg. R-R2-H-0009.

Note: The liner does not require reassembly each time the package is used. Only the top packing assembly is removed and reattached after loading the packing canister.

2. The packing canister is lowered into the liner cavity by hand using the nylon strap attached to the canister lid.

3. The top packing assembly is aligned over the four holes for the closure screws and the screws are installed and torqued to 15 ± 2 lb-in.

4. Refractory material thermal blanket (Fiberfrax® HSA™ ceramic fiber insulation) is placed on top of the fiberboard top packing assembly.

5. The drum lid with rubber lid gasket is placed on the drum and the lid locking ring is fitted over the lid.

6. The lid locking ring closure bolt is torqued to 45 ± 2 lb-ft while the locking ring is rapped with a soft faced hammer.

7. The overpack drum must be appropriately labeled for the hazard associated with the material being shipped in accordance with 49 CFR, Subchapter C.

Note: If the packaging has been stored in or loaded in a contamination area or an area where contamination is suspected, the outer surface of the package must be checked for surface contamination. Any surface contamination must be below 22 dpm/cm^2 for the package to be shipped (49 CFR §173.443).

IV.E.2 *Procedures for Unloading Package*

The customer unloads the SR-101 Inert Reservoir Package as a typical drummed commodity, accounting for facility-specific reservoir handling and safety requirements and radiation and contamination control. For each particular configuration, the unloading procedures are a reverse of the loading procedures.

IV.F. Acceptance Tests and Maintenance Program

IV.F.1 *Acceptance Tests*

SRS acceptance tests check the SR-101 packaging upon receipt.

IV.F.1.a Visual Inspection

Visual inspections ensure the SR-101 packaging is not reused in a damaged condition that could reduce the capability of the package to protect the reservoirs being shipped. Visual inspection of the following components is made during initial assembly of each package and upon receipt of packaging returned for reuse:

- Overpack Drum dents greater than $^1/_2$-inch require notifying supervision and holes or tears require replacement or repair of the drum.
- Vent holes should be properly covered with tight fitting plastic vent plugs.
- Drum lid must be able to adequately seal.
- Lid gasket must be reaffixed or replaced if necessary.
- Closure bolt must function adequately.
- Fiberboard must be removed and replaced nonrepairable damaged fiberboard discs and rings.
- Anchor bolts (4) to hold the fiberboard top packing assembly to the fiberboard liner assembly must be functional.
- Fiber packing canister should be free of damage such as puncture or tears.
- Polyethylene foam-liner should not have crushed areas of foam.

IV.F.1.b Structural and Pressure Tests

Only the reservoir requires structural and pressure testing. Reservoir manufacturers perform the structural and pressure tests required by reservoir design agencies, principally the proof test to 1.5 times the limit pressure. SRS reservoir acceptance testing includes dimensional verification and a verification proof test up to 1.5 times the limit pressure. The proof test meets the DOT requirement for pressure testing the cylinder in §178.65-11(a).

IV.F.1.c Leak Tests

Only the reservoir requires leak testing. The allowable leakage rate, when pressurized to 1.5 times the limit pressure with helium, must be less than 10^{-9} cc(STP)/sec. After pinch welding, SRS leak tests the reservoir. Reservoirs with a leak rate greater than the procedural limit for that reservoir type are rejected.

IV.F.1.d Component Tests

The reservoir is the only SR-101 package component requiring acceptance testing. Structural, pressure, and leak tests are performed on the reservoir as described in SAR Sections IV.F.1.b and IV.F.1.c above.

IV.F.2 *Maintenance Programs*

The SR-101 packaging components may periodically require repair or replacement. The visual inspection described in SAR Section IV.F.1.a will identify the components that need maintenance or replacement.

IV.F.2.a Structural and Pressure Tests

The SR-101 packaging structural integrity is ensured by keeping the included materials in serviceable condition. No reused package component requires maintenance pressure testing.

IV.F.2.b Leak Tests

No reused SR-101 package component requires leak tests.

IV.F.2.c Subsystem Maintenance

The SR-101 has no subsystem requiring maintenance.

V. SHIPPING AND ACCIDENT EXPERIENCE

The SR-101 Inert Reservoir Package began use in 1993. As of November 1998, approximately 216 loaded package shipments had been made from SRS and an equal number of empty return shipments were made to SRS. No accidents or unusual incidences were noted for the overpack or reservoirs. Historically, the similar SR30J package was also used successfully without any accidents or damage to the reservoirs. Likewise there were no accidents during use of the AL-S1 container in its history of over 200 shipments. An excellent record of safe transport of all DOE reservoirs over the years without incident provides confidence that the reservoirs will continue to be transported safely in the SR-101 Inert Reservoir Package.

VI. PROPOSED TRANSPORTATION MODE

This chapter specifies the transportation modes used in SR-101 Inert Reservoir Package shipments. The shipments must be made via public vehicles or aircraft and operated by DOE employees or authorized DOE contractor personnel. Specifically, DOE Order 5610.1(7)(d) requires that equipment and vehicles meet the requirements of DOE 5610.1 and be DOE approved. The DOE Transportation Safeguards System (TSS), managed by the DOE AL Transportation Safeguards Division (TSD), assures that the above requirements are being met.

VII. DURATION OR SCHEDULE OF EVENTS FOR WHICH DOE AL OFFSITE TRANSPORTATION AUTHORIZATION IS SOUGHT

DOE SR requests that DOE AL grant a 5-year Offsite Transportation Authorization (OTA) for the SR-101 Inert Reservoir Package. If the package is still needed upon expiration of the 5-year OTA, the DOE Office requiring continued package use will ensure another OTA is sought.

VIII. SAFETY EQUIVALENCE TO REGULATORY SPECIFIED PACKAGES

This chapter provides a comparison of the SR-101 Inert Reservoir Package with the applicable DOT regulations. The unique design of the reservoirs does not allow them to meet all the DOT requirements that would otherwise be met by shipments of compressed gas in a commercial setting. Where differences exist, the safety implications of the differences are discussed and the design features of the package that provide at least an equivalent level of safety are described.

VIII.A Comparison with Applicable DOT Regulations

Several parts of the hazardous materials regulations of Title 49 CFR, Subchapter C contain requirements applicable to the SR-101 Inert Reservoir Package. Specifically, Part 172 on hazardous materials tables and communications regulations, Part 173 on general requirements for shipments and packagings, and Part 178 on shipping container specifications apply to the package.

The primary hazards of the contents of the SR-101 Inert Reservoir Package are the stored energy associated with the compressed gas and the flammability of the hydrogen isotope gas fills. Of lesser hazard is the explosive actuators on the squib valves mounted on some reservoirs. The radioactive hazard is minimal due to the low concentrations of tritium which may be present in the compressed flammable gas fills.

This section is organized with requirements applicable to all hazardous material packages listed first, followed by general requirements for compressed gas cylinders and Specification 39 requirements. The requirements for the lesser hazards of squib valves and limited quantities of radioactive material are addressed in the last subsections.

VIII.A.1 *Standard Requirements for All Packages*

The standard requirements for all hazardous materials packaging in §173.24 are applicable to the SR-101 Inert Reservoir Package. Specification 39, the DOT specification that the reservoirs most closely fit, explicitly states that the requirements of §173.24 must be met by the cylinders [reservoirs].

Requirement—

> §173.24(a) - "Each package used for shipping hazardous materials under this Subchapter shall be so designed and constructed, and its contents so limited, that under conditions normally incident to transportation: (1) there will be no significant release of hazardous materials to the environment; (2) the effectiveness of the packaging will not be substantially reduced; and (3) there will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging".
>
> Discussion—
>
> SAR Section IV.B.6 describes the successful performance of the SR-101 package under normal conditions of transport. There are no mixtures of gases or vapors that are either generated or can combine to cause a sudden increase of heat or pressure or an explosion in the package under normal conditions of transport.

Requirement—

> §173.24(b) - "Materials for which detailed specifications for packaging are not set forth in this part must be securely packaged in strong, tight packages meeting the requirements of this section".
>
> Discussion—
>
> Detailed specifications applicable to the reservoirs are provided in §178.65 - Specification 39. Also, the general requirements for compressed gas cylinders in §173.301 call for strong outside packagings for

Specification 39 cylinders [reservoirs].

Requirement—

§173.24(c) - "Packagings used for the shipment of hazardous materials under this Subchapter shall, unless otherwise specified or exempted therein, meet all of the following design and construction criteria".

§173.24(c)(1) - "Each specification container shall be marked as follows... (v) Packaging which does not comply with the applicable specifications listed in Parts 178 and 179 of this subchapter [Subchapter C] must not be marked to indicate such compliance".

Discussion—

The reservoir markings do not indicate DOT specification compliance. The overpack drum is marked "DOT 17H". The outside of the overpack drum is also marked in accordance with the requirements of 49 CFR 172, Subpart D.

Requirement—

§173.24(c)(2) - "Steel used shall be low-carbon, commercial quality steel. Stainless... or other similar quality steels are applicable".

Discussion—

The overpack drum is stainless steel. The reservoirs are made of steel meeting the minimum requirements specified in SAR Section IV.B.1.a, Item 8.

Requirement—

§173.24(c)(3) "Lumber used..."

Discussion—

This requirement is not applicable.

Requirement—

§173.24(c)(5) - "Packaging materials and contents shall be such that there will be no significant chemical or galvanic reaction among any of the materials in the package".

Discussion—

All the dissimilar contacting materials were identified in the SR-101 Inert Reservoir Package. No adverse chemical or galvanic reactions will occur between these materials under normal conditions of transport as concluded in SAR Section IV.B.4.c.

Requirement—

§173.24(c)(6) - "Closures shall be adequate to prevent inadvertent leakage of the contents under normal conditions incident to transportation..."

Discussion—

SAR Section IV.B.4.b describes the closure for the overpack drum and Section IV.D.1.d describes the welded closure of the reservoir. The overpack drum contains the reservoir and the reservoir contains the compressed gas under normal conditions of transport.

Requirement—

§173.24(c)(7) "Nails, staples..."

Discussion—

This requirement is not applicable.

Requirement—

§173.24(c)(8) - "The nature and thickness of the packaging shall be such that friction during transport does not generate any heating likely to cause failures".

Discussion—

The reservoirs are restrained in strongbacks and/or packed in foam that prevents any heat generating friction between the reservoir and other package components. The stainless steel drum is not sensitive to the levels of friction that may occur during transport. The extensive shipping experience of similar packages has not shown friction to be a problem.

Requirement—

§173.24(d) - "Polyethylene packaging and receptacles".

Discussion—

This requirement is not applicable.

Requirement—

§173.24(e) "For specification containers, compliance with the applicable specifications in Parts 178 and 179 of this Subchapter shall be required in all details, except as otherwise provided in this Subchapter".

Discussion—

SAR Section VIII.A.4 discusses the compliance of the reservoirs with Specification 39.

VIII.A.2 *General Requirements for Shipment of Compressed Gases in Cylinders*

49 CFR 173.301 provides the general requirements for compressed gas cylinder shipments. The following analysis compares the reservoir with DOT regulations. The hazardous materials table of §173.101 lists §173.302 as containing the specific requirements for packaging containing mixtures of nonliquefied compressed gases. In turn, §173.302 specifies that the requirements of §173.301 are to be met for cylinders (reservoirs) with the types of gas fills the reservoirs will carry.

Requirement—

§173.301(a) - "Gases capable of combining chemically. A cylinder charged with compressed gas must not

contain gases or materials that are capable of combining chemically with each other or with the cylinder material so as to endanger its serviceability".

Discussion—

The reservoir fills do not contain gases that may chemically combine with each other or the reservoir material so as to limit the reservoir serviceability.

Requirement—

§173.301(b) - "Ownership of container. A container charged with a compressed gas must not be shipped unless it was charged by or with the consent of the owner of the container".

Discussion—

DOE is the owner of the reservoirs and all reservoirs are filled (charged) by DOE facility contracting organizations (i.e., WSRC) under the direct management of DOE.

Requirement—

§173.301(c) - "Retest of container".

Discussion—

This requirement is not applicable since the reservoir is normally one time use.

Requirement—

§173.301(d) - "Manifolding containers in transportation".

Discussion—

The reservoirs are not interconnected with a manifold, therefore this requirement is not applicable.

Requirement—

§173.301(e) - "Container pressure. The pressure in the container at 70°F must not exceed the service pressure for which the container is marked or designated".

Discussion—

This requirement is specified as a reservoir requirement for shipment in SAR Section IV.B.1.b, Item 4.

Requirement—

§173.301(f) - "Container pressure at 130°F. The pressure in the container at 130°F shall not exceed 5/4 times the service pressure".

Discussion—

This requirement is specified as a reservoir requirement for shipment in SAR Section IV.B.1.b, Item 5.

Requirement—

§173.301(g) - "Container valve protection. Containers charged with flammable... gases must have their valves protected by one of the following methods... (2) by boxing or crating the containers so as to give proper protection to the valves".

Discussion—

The reservoir fill stems can be considered analogous to cylinder valves in that they extend beyond the body of the reservoir. The fill stems are protected in two ways. The shorter fill stems are protected by plastic caps that are clamped on or screwed on, metal caps that are screwed on, or by squib valves mounted over the stems. The longer fill stems are secured to strongback assemblies. Additional protection is provided to the reservoir fill stems by the SR-101 overpacking consisting of the stainless steel DOT-17H overpack drum, fiberboard assembly, and inner packing canister with polyethylene liner.

Requirement—

§173.301(h) - "Compressed gas containers. Compressed gases must be in metal containers built in accordance with the DOT specifications, as shown below, in effect at the time of manufacture, and marked as required by the specification and the regulation for retesting if applicable..."

Discussion—

SAR Section VIII.A.4 discusses the compliance of the reservoirs with Specification 39.

Requirement—

§173.301(i) - "Foreign cylinders in domestic use...and §173.301(j) - Charging of foreign cylinders for export..."

Discussion—

This requirement is not applicable to reservoir shipments.

Requirement—

§173.301(k) - "Outside packaging. Specification 39 must be shipped in strong outside packaging. (1) Outside packagings must provide protection for the cylinder. Unless the cylinder has a protective collar or neck ring, the outside packaging must provide protection to the valve against accidental functioning and damage".

Discussion—

The SR-101 overpacking meets this requirement, as demonstrated in preceding SAR chapters and as discussed for the §173.301(g) requirement above.

Requirement—

§173.301(l) - "Specifications 3AX, 3AAX, and 3T cylinders..."

Discussion—

This section deals with cylinders other than the Specification 39 and is not applicable.

VIII.A.3 *Charging of Cylinders with Non-Liquefied Compressed Gases*

The hazardous materials table of §173.101 lists §173.302 as containing the specific requirements for packaging containing mixtures of nonliquefied compressed gases.

Requirement—

§173.302(a) - "Detailed requirements. Nonliquefied compressed gases... for which charging requirements are not definitely prescribed in §173.304(a)(2) must be shipped, subject to §173.301, and §173.305 in specification containers as follows:...Specification 39..."

Discussion—

SAR Section VIII.A.4 discusses the compliance of the reservoirs with Specification 39.

Requirement—

§173.302(a)(4) - "Specification 39 (§178.65 of this subchapter) cylinder. For flammable gases, internal volume may not exceed 75 cubic inches. Aluminum cylinders..."

Discussion—

This requirement is specified as a reservoir requirement for shipment in SAR Section IV.B.1.b, Item 2.

VIII.A.4 *Specification 39 for Non-Reusable Cylinders (40 CRF 178.65)*

49 CFR 173.302 - "Charging of cylinders with nonliquefied compressed gases", specifies the DOT Specification cylinders that are acceptable for use with compressed gas contents. Specification 39, in addition to other specification cylinders, is called out in this section.

Requirement—

§178.65-2 - "Type, size service pressure, and test pressure".

§178.65-2(a) - "Type: Each cylinder must be of seamless, welded, or brazed construction. Spherical pressure vessels are authorized and covered by references to cylinders in this specification".

§178.65-2(b) - "Size limitation: Maximum water capacity may not exceed... (2) 10 pounds (277 cubic inches) for a service pressure in excess of 500 psig." (Note: In the case of flammable gas, the size limitation is 75 cubic inches per §173.302(a)(4))

§178.65-2(c) - "Service pressure: The marked service pressure may not exceed 80% of the test pressure".

§178.65-2(d) - "Test pressure: The minimum test pressure is the maximum pressure of contents at 130°F or 180 psig, whichever is greater".

Discussion—

These requirements are specified as reservoir requirements for shipment in SAR Section IV.B.1.b.

Requirement—

§178.65-3 and §178.65-4 define the DOT required inspections and inspector duties.

Discussion—

Inspections and inspectors within the DOE weapons complex ensure that reservoirs are manufactured, filled and finished according to the design agency design and fabrication specifications.

Requirements—

§178.65-5 - "Material; steel or aluminum".

§178.65-5(a) - for steel materials:

§178.65-5(a)(1) - "The steel analysis must conform to the following: maximum ladle analysis: carbon 0.12 percent, phosphorus 0.04 percent, sulfur 0.05 percent".

Discussion—

A typical austenitic stainless steel conforms to the maximum percentages. This requirement is specified as a reservoir requirement for shipment in SAR Section IV.B.1.b, Item 9.

Requirement—

§178.65-5(a)(2) - "Details for cylinders of seamless steel tubing with integrally formed ends".

Discussion—

This requirement is not applicable.

Requirement—

§178.65-5(a)(3) - "For non-heat treated welded steel cylinders, adequately killed deep drawing quality steel is required".

Discussion—

This requirement is specified as a reservoir requirement for shipment in SAR Section IV.B.1.b, Item 10.

Requirement—

§178.65-5(a)(4) - Details for helical welded cylinders.

Discussion—

This requirement is not applicable.

Requirement—

§178.65-5(c) - "Materials with seams, cracks, laminations, or other injurious defects not permitted".

Discussion—

Quality assurance covering the reservoir fabrication and filling ensures defective materials are not used.

Requirement—

§178.65-5(d) - "Materials used must be identified by any suitable method".

Discussion—

The reservoir manufacture complies with an approved quality assurance program, which requires material identification.

Requirements—

§178.65-6 - "Manufacture".

§178.65-6(b)(7) - "Welded joints must have strength equal to or greater than the minimum strength of the shell material in the finished cylinder".

§178.65-6(c) - "Attachments to the cylinder are permitted by any means which will not be detrimental to the integrity of the cylinder. Welding or brazing of attachments to the cylinder must be completed prior to all pressure tests".

Discussion—

The DOT manufacture requirements are basic in comparison to the stringent requirements imposed on the manufacture of a reservoir. The reservoir manufacture requirements exceed the DOT requirements.

Requirement—

§178.65-6(d) - "Welding procedures and operators must be qualified in accordance with CGA (Compressed Gas Association) Pamphlet C-3".

Discussion—

Welding procedures and operator qualifications meet or exceed the CGA Pamphlet C-3 requirements.

Requirements—

§178.65-7 - "Wall thickness".

§178.65-7(a) - "The minimum wall thickness must be such that the wall stress at the test pressure does not exceed the yield strength of the material of the finished cylinder wall".

§178.65-7(b) - "Calculation of the stress for cylinders must be made by the formula: $S = [P(1.3D^2 + 0.4d2)]/(D^2-d^2)$ where: S = wall stress, in psi; P = test pressure, in psi; D = outside diameter, in inches; d = inside diameter, in inches".

§178.65-7(c) - "Calculation of the stress for spheres must be made by the formula: $S = PD/4t$, where: S = wall stress, in psi; P = test pressure, in psi; D = outside diameter, in inches; t = minimum wall thickness, in inches".

Discussion—

These requirements are specified as requirements for shipment of the reservoir in SAR Section IV.B.1.b. A more conservative thick-wall cylinder formula is provided for use as specified in Appendix 2.

Requirements—

§178.65-9 - "Openings and attachments".

§178.65-9(a) - "Opening and attachments are permitted on heads only".

§178.65-9(b) - Details for cylindrical vessels are given.

§178.65-9(c) - "Unless a head has adequate thickness, each opening must be reinforced by a securely attached fitting, boss, pad, collar, or other suitable means".

Discussion—

These requirements are specified as design criteria for the reservoir in SAR Section IV.B.1.b.

Requirement—

§178.65-9(d) - "Materials used for welded openings and attachments must be of weldable quality and compatible with the material of the cylinder".

Discussion—

Attachments to the reservoirs meet these requirements.

Requirement—

§178.65-10 - "Safety devices. Safety devices must meet the requirements of §173.34(d) of this chapter".

Discussion—

The reservoirs do not meet the requirements for safety devices. Specifically, the reservoirs do not have pressure relief devices. However, the packaging provides an equivalent level of safety. See SAR Section VIII.A.5 for further discussion.

Requirement—

§178.65-11(a) - "Each cylinder must be tested at an internal pressure of at least the test pressure and must be held at that pressure for at least 30 seconds. (1) The leakage test must be conducted by submersion under water or by some other method that will be equally sensitive. (2) If the cylinder leaks, evidences visible distortion, or any other defect while under test, it must be rejected (see §178.65-13)".

Discussion—

Each reservoir is tested to a proof pressure that is a minimum of 2 times the reservoir limit pressure, where the limit pressure is the pressure of contents at 160°F. The reservoir proof pressure is higher than the minimum test pressure required by §178.65-2(c). The reservoirs are helium leak tested at the proof pressure. The allowable leakage rate must be less than 10^{-9}cc(STP)/sec. The reservoirs are tested at the design agency facility and may then be tested again at SRS prior to filling.

Requirements—

§178.65-11(b) - "One cylinder taken from the beginning of each lot, and one from each 1,000 or less successively produced within the lot thereafter, must be hydrostatically tested to destruction. The entire lot must be rejected if (see §178.65-13): (1) A failure occurs at a gage pressure less than 2.0 times the test

pressure; (2) A failure initiates in a braze or a weld or the heat affected zone thereof; (3) A failure is other than in the sidewall of a cylinder longitudinal with its long axis; or (4) In a sphere, a failure occurs in any opening, reinforcement, or at a point of attachment".

Discussion—

The requirement for the minimum burst pressure (burst must not occur at a pressure less than 2.0 times the test pressure) is specified as a reservoir requirement for shipment in SAR Section IV.B.1.b, Item 7. At least one reservoir is taken from each lot and hydrostatically tested to burst pressure. The tested reservoirs have had burst pressures well above the burst pressure requirement.

Failure generally occurs at the girth weld around the diameter of the reservoir. However, some reservoir types burst at the fill stem. These failure locations do not meet the requirement for location as specified above. However, to ensure that there is sufficient safety margin in the welds and attachment points, the reservoirs must meet the following requirement. The tested reservoirs must not fail in the weld, braze, or attachment point at a pressure less than 2.5 times the test pressure.

Requirement—

§178.65-11(c) - "A 'lot' is defined as the quantity of cylinders successively produced per production shift (not exceeding 10 hours) having identical size, design, construction, material, heat treatment, finish, and quality".

Discussion—

A 'lot', as defined in §178.65-11(c), does not apply since reservoir fabrication is a high-quality standard manufacturing process where one reservoir may not be completed in 10 hours.

Requirement—

§178.65-12 - "Flattening test".

Discussion—

This test was not conducted for the reservoir. This test indicates whether a cylinder wall material will tend to fragment upon burst.

Requirement—

§178.65-13 - "Rejected cylinders".

Discussion—

Rejected reservoirs are discarded or reclaimed.

Requirement—

§178.65-14 - "Markings".

Discussion—

49 CFR 173.24(c)(1)(v) prohibits use of the markings described in §178.65-14 on the reservoir. Packaging that does not comply with the specification must not be marked to indicate such compliance. The reservoirs do not meet all Specification 39 requirements and therefore are not marked as such. The overpack drum is

marked DOT-17H. The identification plate on the overpack drum provides the package model number, serial number, and gross weight. The outside of the overpack drum is also appropriately marked and labeled for the hazard associated with the material being shipped.

Requirement—

§178.65-15 - "Inspector's report".

§178.65-15(a) - "The inspector's report must be retained by the manufacturer for a period of 3 years and must be available for examination by representatives of the Department [DOT]".

§178.65-15(b) - "The report must be legible, and contain at least the following information:..."

Discussion—

This requirement is particular to DOT specification package manufacture. Quality assurance documentation details the manufacture, fill, finishing, and history for each reservoir. The QA records are maintained at least 6 months beyond the reservoir service life.

VIII.A.5 *Qualification, Maintenance, and Use of Cylinders*

Specification 39 (§178.65-10) requires that safety devices for the cylinders meet the requirements of §173.34(d) of this chapter.

Requirements—

§173.34(d) - "Pressure relief device systems. No person may offer a cylinder charged with a compressed gas for transportation unless the cylinder is equipped with one or more pressure relief devices... The pressure relief device system must be capable of preventing rupture of the normally charged cylinder when subject to a fire test conducted in accordance with CGA [Compressed Gas Association] Pamphlet C-14..."

§173.34(d)(1) - Notes 1 and 3 apply. "Note 1: Safety relief devices are required on Specifications 9, 40, 41, and 39 (§178.65 of this subchapter) cylinders... Note 3: Safety relief devices are required on cylinders charged with nonliquefied gases to a pressure of 1,800 psi or higher at 70°F".

Discussion—

To address the lack of reservoir pressure relief, the outer package (insulated overpack drum) has been designed to protect the reservoirs from a fire accident. Reservoir burst is prevented by the thermal insulating capability of the package. The 10 CFR 71.73 hypothetical accident fire test conditions of 1475°F for 30 minutes are considered to be reasonably conservative requirements for the SR-101 package to meet. The maximum temperature that the reservoir could reach in the prescribed fire is 230°F. The pressure at this temperature is below the burst pressure of the reservoir. See SAR Section IV.C for a detailed discussion of the performance of the SR-101 Inert Reservoir Package in the hypothetical fire accident.

VIII.A.6 *Requirements for Limited Quantities of Radioactive Materials*

The compressed flammable gas fill may contain trace amounts of tritium in quantities defined as limited quantities of radioactive material, therefore, selected requirements of 49 CFR Subpart I, Radioactive Materials apply.

Note: These requirements only apply to shipments of reservoirs with gas fills containing trace amounts of tritium.

Requirement—

§173.421 - "Radioactive materials whose activity per package does not exceed the limits specified in §173.423 (20 Curies per package for tritium) are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements of this subchapter and requirements of this subpart if:

§173.421(a) - "The materials are packaged in strong, tight packages that will not leak any of the radioactive materials during conditions normally incident to transportation;"

Discussion—

The SR-101 Inert Reservoir Package meets the requirements of a strong, tight package and does not leak its contents under normal conditions of transport. See SAR Section IV.B.6 for a detailed discussion.

Requirement—

§173.421(b) - "The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour;"

Discussion:

Tritium is a "soft" beta emitter. The trace amount of tritium that may be present in the reservoir is effectively shielded by the package materials resulting in no measurable radiation levels at the external surface of the package.

Requirement—

§173.421(c) - "The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in §173.443(a);"

Discussion—

At SRS, the surface contamination on the exterior of the overpack drum is maintained to clean area limits, which are less than the limit of 22 dpm/cm^2 allowed in §173.443(d) for a closed transport vehicle used solely for the transportation of radioactive material packages.

Requirement—

§173.421(d) - "The outside of the inner packaging or if there is no inner packaging, the outside of the packaging itself bears the marking 'Radioactive';"

Discussion—

The outside of the reservoir packing canister will be marked 'Radioactive' for those reservoir fills that meet the limited quantity of radioactivity definition.

Requirement—

§173.421(e) - "Except as provided in §173.424, the package does not contain more than 15 grams of uranium-235; and..."

Discussion—

This requirement is not applicable.

Requirement—

§173.421(f) - "The material is otherwise prepared for shipment as specified in §173.421-1."

Discussion—

See the discussions for the requirements in §173.421-1(a) and (b) below.

Requirement—

§173.421-1(a) - "Excepted radioactive materials prepared for shipment under the provisions of §173.421, §173.422, §173.424, or §173.427 must be certified as being acceptable for transportation by having a notice enclosed in or on the package, included with the packing list, or otherwise forwarded with the package. This notice must include the name of the consignor or consignee and the statement 'This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity..."

Discussion—

The SR-101 package, which is classed for the compressed gas hazard, is excepted from this requirement per §173.421-2(c).

Requirement—

§173.421-1(b) - "An excepted radioactive material classed radioactive material and prepared for shipment under the provisions of §173.421...is not subject to the requirements of this subchapter, except for: (1) Sections 171.15, 171.16, 174.750, 176.710 and 177.861 of this subchapter pertaining to the reporting of incidents and decontamination when transported by a mode other than air; or (2) Sections 171.15, 171.16, 175.45, and 175.700(b) of this subchapter pertaining to the reporting of incidents and decontamination if transported by aircraft. After May 2, 1991, it is also necessary to comply with §173.448(f) and §175.700(c) of this subchapter".

Discussion—

Incidents as defined in §171.15 and §171.16 are reported by DOE AL as required by §171.15. The package contents are classed for the compressed gas hazard and are not classed radioactive material, therefore, the remaining subsections called out in §173.421-1(b) are not applicable.

Requirement—

§173.421-2(a) - "Except as provided in paragraph (b) of this section or in §173.4 of this subchapter, when a limited quantity radioactive material meets the definition of another hazard class, it shall be: (1) Classed for the additional hazard; (2) Packaged to conform with requirements specified in §173.421(a) through (e)...; (3) Offered for transportation in accordance with requirements applicable to the hazard for which it is classed".

Discussion—

The SR-101 Inert Reservoir Package has been classed for non-flammable and flammable compressed gas. The package conforms with the requirements of §173.421(a) through (e). The package either meets the specific DOT requirements for compressed gas shipments or meets the intent with features providing equivalent safety.

Requirement—

§173.421-2(c) - "A limited quantity radioactive material which is classed other than radioactive material under provisions of paragraphs (a) or (b) of this section is excepted from requirements of §173.421-1(a),...of this subchapter if the entry 'Limited quantity radioactive material' appears on the shipping paper in association with the basic description".

Discussion—

For those reservoir fills with possible limited quantities of radioactive material, the shipping papers must indicate "Limited quantity radioactive material" along with compressed gas, n.o.s. as described in 49 CFR 172.200 Subpart C.

Requirement—

§173.421-2(d) - "After May 2, 1991, a limited quantity radioactive material may not be offered for transportation aboard a passenger-carrying aircraft unless that material is intended for use in, or incident to, research, medical diagnosis or treatment".

Discussion—

Reservoirs will not be shipped on commercial passenger-carrying aircraft.

VIII.A.7 ***Requirements for Squib Valves***

Some reservoirs have squib valves attached. The squibs contain a 1.4S explosive that drives the valve actuator. The applicable requirement for shipment of this material is in Part 173, "Subpart C - Explosives and Blasting Agents; Definitions and Preparations".

Requirement—

§173.87 - Explosives in mixed packaging.

"Unless specifically authorized in this subchapter, explosives may not be packaged in the same outside packaging with other articles unless packaged by the DOD in accordance with §173.7(a)".

Discussion—

This requirement is understood to mean that the 1.4S explosive squibs cannot be shipped with other hazard class material. The reservoirs with attached squibs are transported in support of the weapons program and, therefore, come under the exemption for U.S. Government material in §173.7 provided the packaging is of equal or greater strength and efficiency than the otherwise required DOT packaging. The SR-101 packaging fulfills this requirement (see the discussion for the requirement in §173.106(a) below).

Requirement—

§173.106(a) - "Cartridge bags, empty, with black powder igniters, igniters, safety squibs, electric squibs, delay electric igniters, igniters fuse-metal clad, and fuse lighters or fuse igniters must be packed in strong fiberboard or wooden boxes or wooden or metal barrels or drums properly described and properly marked with the name of the article packed therein".

Discussion—

The SR-101 Inert Reservoir Package meets the requirement for a strong drum. The requirement is for squibs

shipped unattached. The squibs in the package will be attached to reservoirs. An inadvertent detonation of the charge would actuate the squib resulting in release of the pressurized gas into the overpack. The hazard from the detonation of the charge is overshadowed by the hazard from the sudden release of the gas into the overpack. To prevent an accidental release from a static charge, shorting clips are attached to the squib to prevent inadvertent actuation of the squib from a static charge. The explosive charge can detonate in a high heat environment, greater than what would be experienced under normal conditions of transport. The SR-101 overpack protects the squib from high temperatures from a fire accident condition as described in SAR Section IV.C.3.

VIII.B Summary of Package Safety Equivalency

The unique design and service requirements of the gas reservoirs does not allow for them to meet all the applicable DOT requirements as specified in SAR Section VIII.A above. However similar requirements and stringent design, fabrication, and testing standards provide at least an equivalent level of safety when combined with a Type B design overpackaging.

IX. QUALITY ASSURANCE REQUIREMENTS

This chapter describes the SR-101 Inert Reservoir Package quality assurance requirements. The requirements address the quality assurance methodology and applicable areas of the SR-101 packaging design, purchasing, fabrication, handling, shipping, storage, cleaning, assembly, inspection, testing, operation, maintenance, repair, and component modification.

IX.A Organization

IX.A.1 *Westinghouse Savannah River Company*

Westinghouse Savannah River Company (WSRC) is the SRS Management Contractor acting for the DOE and conducts it's business consistent with the requirements of it's DOE approved QA Plan[18] as presented in the Site QA Manual WSRC 1Q.[19] All organizational elements of the WSRC are required to implement QA programs, QAP 1-1,[19] which comply with appropriate sections of ASME/ANSI NQA-1.[21]

An Organizational Chart relative to packaging development, quality assurance, and the package user is shown in Figure 4.

IX.A.2 *Defense Programs Division/Packaging User*

The Defense Programs Division uses the SR-101 Inert Reservoir Package to transport inert reservoirs to offsite locations. Defense Programs Division management set the requirements for, and are in the review and approval process for this packaging design. They have established procedures and a quality control system that assures the SR-101 packaging and it's operation, maintenance, and use are in accordance with the SAR.

Packaging users are responsible for the quality of their activities and products. Providing management an independent measurement of the quality program adequacy and effectiveness is a responsibility of the user organization.

Personnel in the various areas of packaging use are to have been sufficiently trained and have acquired expertise in their respective fields.

Other user organizations may use the SR-101 packaging by establishing similar procedural controls under their own approved QA program.

IX.A.3 *Design Organization*

The SRS Packaging and Transportation Group (P&TG) is the overpack Packaging Design Agency and Cognizant Technical Function (CTF) to develop and oversee the SR-101 packaging and other certified packagings used by SRS to transport weapons components and radioactive materials to offsite locations.

IX.A.4 *Quality Assurance*

The Savannah River Technology Center (SRTC) Quality Assurance Department is the Cognizant Quality Function (CQF) designated to provide input and oversight for the CTF programs. The QA organization has a separate reporting chain to management that is independent of the design agency as shown in Figure 4.

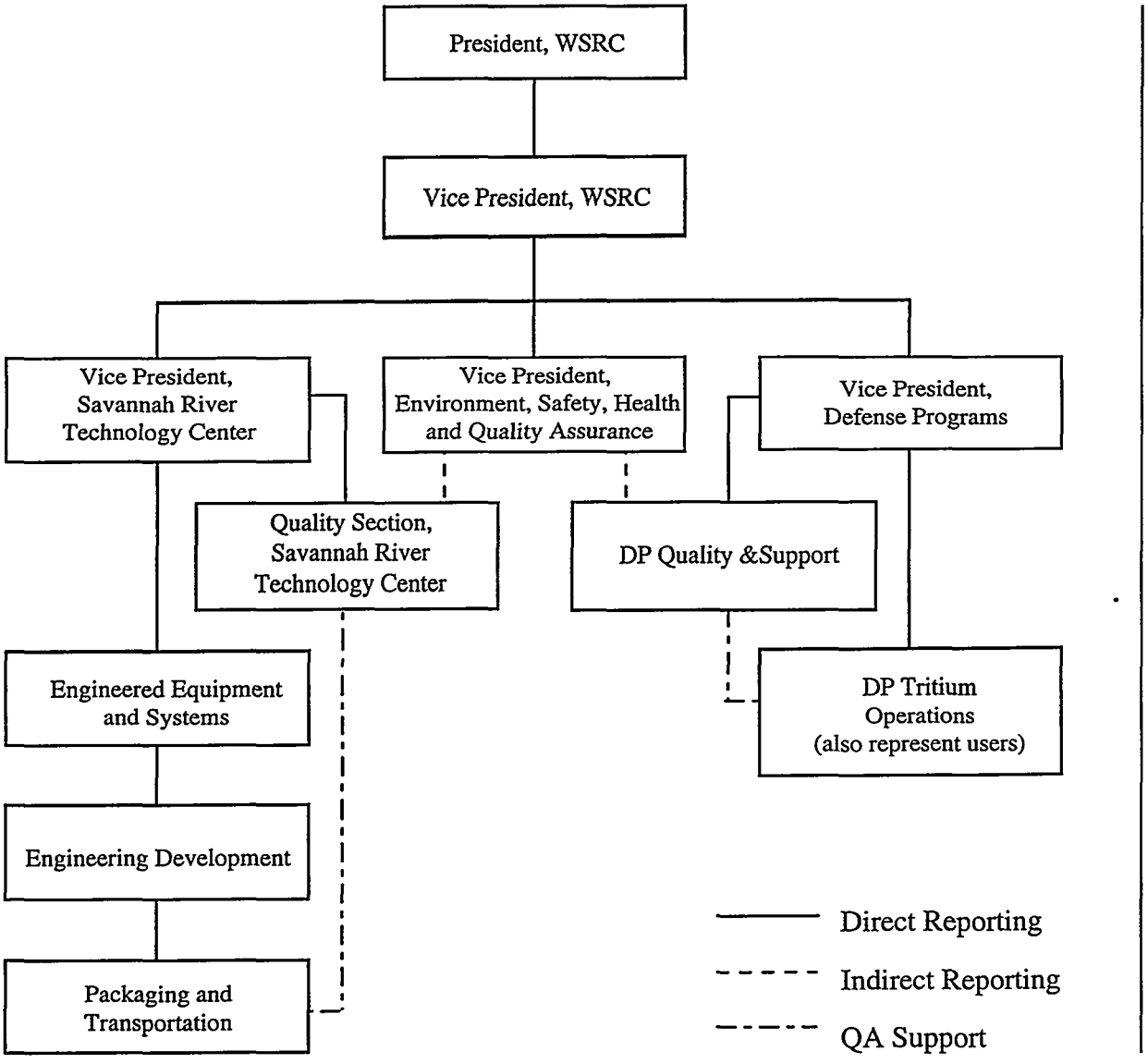


Figure 4. Organizational Chart

The P&TG is responsible for ensuring that an appropriate quality assurance program is implemented to execute the SR-101 packaging design and development effort. The P&TG Quality Program is in accordance with the WSRC 1Q manual and is managed to assure compliance with the NRC regulations of 10 CFR 71, Subpart H, the DOT regulations of 49 CFR 100-179, as well as applicable DOE orders.

IX.B Quality Assurance Program

IX.B.1 *General*

The Westinghouse Savannah River Quality Assurance Plan is based on the requirements given in DOE Order 5700.6.[23] The WSRC QA Manual 1Q provides the procedures to implement the QA Plan. The P&T Quality Assurance program is also implemented through the 1Q Manual and complies with DOE Orders 1540.2,[3] 5480.3,[24] 10 CFR 71,[13] and NQA-1. The P&TG controls activities related to the design, procurement, fabrication, construction, maintenance, and modification of packaging. Control of fabrication of shipping packaging components is ensured by imposing appropriate sections of NQA-1 requirements in the procurement specifications. All Westinghouse employees are responsible for effective implementation of the WSRC 1Q Manual within the limits of their job assignments. WSRC management assesses at least annually the adequacy and effectiveness of the QA Program to ensure proper implementation. Documentary evidence and independent verification, where appropriate, are performed to demonstrate that specific objectives are achieved.

IX.B.2 *Defense Programs Division Program*

The SRS reservoir quality assurance program ensures the reservoirs meet the reservoir design agency design specifications. The quality assurance program also ensures that the overpacking provides adequate reservoir safety. The program includes an overall quality assurance indoctrination and training program, training programs for personnel performing specific tasks, quality assurance implementation and acceptance procedure requirements, and independent inspection personnel requirements.

IX.B.3 *SR-101 Packaging Program*

The SR-101 inert reservoir packaging was designed and evaluated as described in SAR Section IV.B. Quality assurance requirements were invoked in the design, procurement, fabrication, assembly, testing, maintenance, and use of the packaging to ensure established standards are maintained. Items and activities to be controlled and documented are described herein.

The WSRC QA Procedure Manual 1Q, in conjunction with procedures specifically written to cover shipping activities, are implemented by the appropriate packaging user group in the use of this packaging.

Operators are trained as specified in QAP 5-1 in the use of the packaging, and their training documentation placed in their training files. Training of user operation personnel will be accomplished primarily by operation supervision, with assistance from the site QA group as appropriate. Independent monitoring, review, and auditing of activities will be provided by the site QA Group.

Organizations other than WSRC may use the SR-101 packaging by using these procedures or by developing their own equivalent procedures under their own DOE-approved QA program.

IX.C Design Control

Reservoir—

The specific reservoir design agency controls the design and sets the product specifications.

Overpacking—

Packaging users communicate any needed overpacking design changes to the SRS Packaging and Transportation Group, which maintains overpacking design control. Design changes impacting overpacking safety require independent review and approval by the SRS Packaging and Transportation Group, which in turn coordinates design changes with DOE AL. The shipper is responsible for ensuring that SR-101 Inert Reservoir Packages meet the SAR requirements.

IX.D Procurement Document Control

Packaging Procurements—

SRS uses a quality documented, controlled procurement cycle to purchase additional packaging and components. Designated procurement personnel are trained and qualified, and their qualifications are documented. The purchase requisition initiator is responsible for including applicable quality assurance requirements and gaining proper approval signatures. Purchase requisition changes require approval by the original approval organization.

Replacement Part Procurements—

The Cognizant Technical Function is performed by P&TG personnel to ensure replacement parts are equivalent to original parts. If equivalent parts are not available, P&TG organization will reevaluate the use of substitute parts and update the SAR as necessary. Necessary part specifications are included in the design drawings.

Because the SAR addresses the procurement of drum overpacks, prequalification of vendors is not required, although specific items as shown in Figure 1 of Specification P12346 (see Appendix 1) must be documented as indicated. P&TG provides support to the Defense Programs Division to generate the procurement specification and to ensure the SAR requirements are satisfied.

IX.E Instructions, Procedures, and Drawings

Packaging Use—

Activities concerning loading, packaging, and shipping are performed in accordance with written operation procedures, developed by the user, to implement the requirements provided in SAR Section IV.E. Packaging first time usage inspections, sequential loading and unloading operations, technical constraints, acceptance limits, and references are specified in the procedures.

Repair, Rework and Maintenance—

Users are to implement written procedures to systematically identify and perform routine repair and rework that is necessary. For significant repair and rework, personnel performing the work notify appropriate management and prepare a nonconformance report (NCR). All NCR repair and rework dispositions require approval of the CTF before work is initiated.

IX.F Document Control

All reservoir processing documents are controlled. These documents include but are not limited to procedures, drawings, and product specifications. Reservoir data sheets are microfilmed and maintained until the reservoir is retired plus an additional six months. At SRS, Management Services Department controls all controlled distribution documents and maintains a control document index. The Defense Programs Division classified document control conforms with the SRS Security Manual and written procedures.

The SRS Packaging and Transportation Group controls the SR-101 Inert Reservoir Package SAR revisions. The SAR and supporting documents are filed with and controlled following SRS procedures. Defense Programs Division

controls package use and maintenance procedures and applicable procurement documents. SRS controls packaging design drawings.

Document revisions require review and approval by the original approval organization.

IX.G Control of Purchased Material, Equipment, and Services

Established practices ensure that purchased materials, equipment, and services conform to procurement document requirements. WSRC Manual 1Q, QAP-7 describe actions and responsibilities in detail.

IX.H Identification and Control of Materials, Parts, and Components

Individual serial numbers and other design agency required markings uniquely identify each reservoir. Packaging user procedures are to ensure accountability by invoking reservoir processing data sheets and instructions using the reservoir type and serial number as identifiers. The Automated Reservoir Management System (ARMS) provides computerized inventory of all reservoirs and storage locations within the SRS tritium facility.

The packaging user is to follow design drawings and reservoir design agency specifications to ensure SR-101 overpacking material, parts, and components are properly identified.

IX.I Control of Special Processes

Seal welding, finishing, leak testing, and radiographing the reservoirs constitute the SR-101 package special processes performed at SRS. The packaging user is to ensure personnel, equipment, and procedure qualification records are established, filed, and kept current. Personnel performing the special processes are qualified or certified, as appropriate.

IX.J Inspection Control

Reservoir processing operations are to incorporate quality verification and design specification conformance inspections. At SRS, operating procedures control self-checking and in-process inspections. Certified inspectors are to perform independent inspections and reservoir acceptances using DOE approved quality assurance inspection procedures (QAIP).

SR-101 Inert Reservoir Package inspection control is to be performed by trained personnel using approved procedures. Written procedures are to control SR-101 packaging receipt, maintenance inspections and final package inspections.

IX.K Test Control

The packaging user is to implement approved procedures to control reservoir testing, including those addressed in SAR Section IX.I. Testing determines the reservoir acceptance, rejection, or other disposition. Testing is performed by trained and qualified or certified personnel, as appropriate.

P&TG uses approved special test procedures and trained and qualified personnel when performing package testing that will be used in support of the SAR.

IX.L Control of Measuring and Test Equipment

All facility measuring and test equipment (M&TE) is to be controlled. Control includes specification of re-calibration intervals and ensuring process uncertainties are maintained within prescribed limits. M&TE includes devices and systems such as reference standards, transfer standards, tools, gages, and instruments that are used to make reservoir acceptance decisions and to verify specified package assembly functions.

IX.M Handling, Storage, and Shipping

Approved operating procedures are to be used to control SR-101 Inert Reservoir Package handling, storage, and shipping. These procedures are to incorporate necessary DOE, DOT, and reservoir design agency requirements. At SRS, the SR-101 packaging is to be kept in the tritium facility at storage level B. Other users are to provide at least equivalent storage conditions.

IX.N Inspection, Test, and Operating Status

Packaging users are to use status indicators to control reservoir test, inspection, and operating status.

IX.O Control of Nonconforming Materials, Parts, or Components

Reservoir nonconformances are to be controlled using nonconformance reports and reservoir hold tag. Appropriate management is to determine reservoir nonconformance dispositions. Approved procedures are to address nonconformance controls of other reservoir packaging materials, parts, or components. Nonconforming materials, parts, and components are segregated for disposition. All overpackaging nonconformance reports with repair or rework dispositions are to be reviewed and evaluated by the CTF (P&TG) before disposition.

IX.P Corrective Action

Conditions adverse to SR-101 Inert Reservoir Package quality are identified according to the technical incident reporting procedure for nuclear materials processing facilities.

The corrective action system is to be based on reviews of surveillance and audit findings, quality control procedure deviations, quality verification inspection results, NCRs and tritium facility incident reports. The quality organization is to ensure corrective actions are closed out.

IX.Q Quality Assurance Records

All records containing reservoir processing information are maintained for six months past the reservoir life, as required by the reservoir design agency. Other records to be controlled include but are not limited to packaging design and procurement documents, shipping documents, necessary personnel and equipment qualifications and certifications, and corrective actions reports.

IX.R Surveillance

The Defense Programs Division is responsible for the reservoir processing surveillance program. The surveillance program includes planning, scheduling, performing, and retaining records from surveillance and verifying correction action closeouts.

IX.S Quality Improvement

The packaging user is to incorporate quality improvement as a specific requirement in each of the above listed sections.

IX.T Process Computer Software Control

All Defense Programs Division software developed after October 1, 1984, and impacting reservoir processing must comply with the Defense Programs Division quality assurance plan. Computer software used for packaging design analysis and safety analysis in critical applications is controlled under WSRC 1Q, QAP 20-1. The procedure defines the responsibilities and requirements for software development, procurement, modification, maintenance, and application.

(This page intentionally left blank)

REFERENCES

1. U.S. Department of Energy Order 5610.1, *Packaging and Transporting of Nuclear Explosives, Nuclear Components, and Special Assemblies*, September 11, 1979.

2. U.S. Department of Energy, Albuquerque Field Office, Supplemental Directive AL 5610.1, Rev.1, *Packaging and Transportation of Components and Special Assemblies Associated with the Nuclear Weapons Program*, October 1, 1992.

3. U.S. Department of Energy Order 1540.2, *Hazardous Material Packaging for Transport-Administrative Procedures*, September 30, 1986.

4. Memorandum, M. J. Zamorski, Albuquerque Operations Office, to R. L. Chandler, et al., Savannah River Site, "Inert Reservoir Working Group Meeting June 13, 1989", July 11, 1989.

5. Proposed Revision 2 to Regulatory Guide 7.9, *Standard Format and Content of Part 71 Applications for Approval of Packaging for Radioactive Material*, U. S. Nuclear Regulatory Commission, May 1986.

6. Regulatory Guide 7.10, Revision 1, *Establishing Quality Assurance Programs for Packaging Used in the Transport of Radioactive Material*, U.S. Nuclear Regulatory Commission, June 1986.

7. Title 49, Code of Federal Regulations, Subtitle B, Chapter I, Parts 100 - 199, *Research and Special Programs Administration*, Department of Transportation, October 1, 1989 Ed. and December 1, 1992 Ed.

8. Enz, G., *Loading Data* (U), WSRC-RP-92-227, Savannah River Site, Aiken, South Carolina, February 5, 1992 (SECRET-RD).

9. Edling, D. A., D. R. Hopkins, and R. L. Williams, *DOE Evaluation Document for DOT 7A Type A Packaging*, MLM-3245, DOE/DP/00053-H1, Mound, Monsanto Research Corporation, Miamisburg, Ohio, March 1987.

10. Lewellen, E. E., *Drum and Board-Type Insulation Overpacks of Shipping Packages for Radioactive Materials,* DP-1292, E.I. Du Pont De Nemours & Company, Savannah River Laboratory, Aiken, South Carolina, July 1972.

11. Walker, M. S., *Packaging Materials Properties Data*, Y/EN-4120, Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee, January 1991.

12. Caskey, G. R., *Hydrogen Compatibility Handbook for Stainless Steels,* Dupont Report DP-1643, Savannah River Laboratory, Aiken, South Carolina, June 1983.

13. Title 10, Code of Federal Regulations, Chapter 1, Part 71, *Packaging and Transportation of Radioactive Material*, Nuclear Regulatory Commission, January 1, 1991.

14. Bolen, J. L., B83 *Gas Transfer System Development* (U), SAND87-8207, Sandia National Laboratories, Albuquerque, New Mexico, March 1987 (SECRET-RD).

15. *A Review of the Safety Features of 6M Packagings for DOE Programs*, SAND88-3005, U.S. Department of Energy Specification-6M Safety Task Force, Sandia National Laboratories, Albuquerque, New Mexico, September 26, 1988.

16. Carrell, J. T., *Vibration Test of the W84 MC3430 Reservoir* (U), RS 8445, Sandia National Laboratories, Livermore, California, January 12, 1993 (SECRET-RD).

17. Van Alstine, M. N., *Safety Analysis Report-SR30J Inert Reservoir Package* (U), WSRC-RP-89-1312, Westinghouse Savannah River Company, Aiken, South Carolina, August 1991 (SECRET-RD).

18. Westinghouse Savannah River Company, *Quality Assurance Plan*, WSRC-1-05, Aiken, South Carolina.

19. Westinghouse Savannah River Company, *Quality Assurance Manual*, WSRC-1Q, Aiken, South Carolina.

20. (deleted)

21. American Society of Mechanical Engineers/American National Standards Institute, *Quality Assurance Program Requirements for Nuclear Facilities*, ASME/ANSI NQA-1-1983.

22. (deleted)

23. U.S. Department of Energy, *Quality Assurance*, DOE 5700.6B or subsequent document.

24. U.S. Department of Energy, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*, DOE 5480.3, July 9, 1985.

Appendix 1

(This page intentionally left blank)

APPENDIX 1 SR-101 PACKAGE OVERPACKING REFERENCE INFORMATION

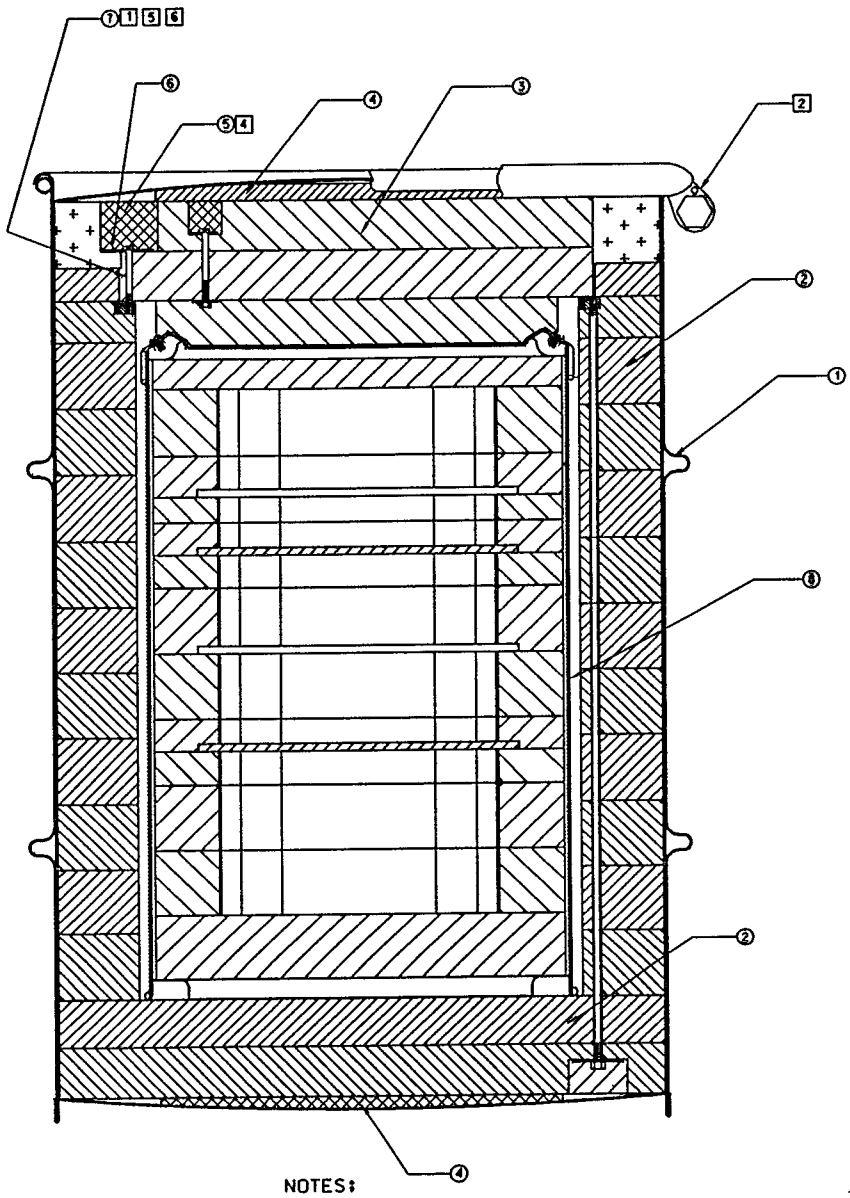
The following drawings and specifications are presented for informational purposes only. Obtain current engineering copies if other than informational use is required. The drawings and specifications, current as of November 1998, may not be updated throughout the five year SR-101 Inert Reservoir Package certification life. No overpacking changes and no reservoir changes impacting transportation safety are anticipated.

Appendix 1 contents in order presented:

Dwg. R-R0-H-0004-01, Rev. 1	"Inert Reservoir Packaging (SR-101) Drum Assembly and Details"
Dwg. R-R2-H-0009-01, Rev. 1	"Inert Reservoir Packaging (SR-101) Fiberboard Assembly and Details"
Dwg. R-R4-H-0057-01, Rev. 1	"Inert Reservoir Packaging (SR-101) Reservoir Packaging Canister Details"
Specification P12346	"Procurement Specification for DOT-17H 30-Gal Drum"

(This page intentionally left blank)

ANALYZE THIS PRINT FOR
SAFETY CONSIDERATIONS



NOTES:

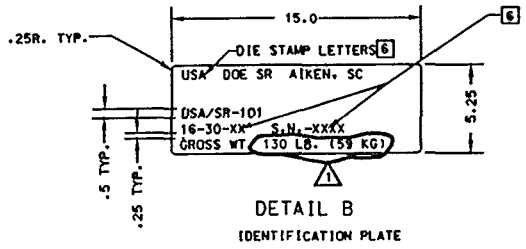
1. INSTALL SCREWS (ITEM 7) INTO R-R2-H-0009L (ITEM 6) AND TORQUE TO APPROXIMATELY 15 LB-IN.
2. SEAL CONTAINER WITH TAMPER PROOF SEAL IN ACCORDANCE WITH APPLICABLE SECURITY REGULATIONS.
3. THE CLEARANCE BETWEEN THE TOP OF THE FIBERBOARD DISC (ITEM3) AND THE TOP OF THE DRUM BODY IS TO BE .75" ± .13. (1)
4. FILL C'BORE WITH "CERABLANKET" CERAMIC FIBER INSULATION (ITEM 5), OR EQUAL. FOUR PLACES.
5. ITEM 7 SCREW TO BE TAPERED AT END FOR EASE OF INSTALLATION.(APP. .1" AT 45°)
6. LOCATE HOLES FOR ITEM 7 SCREW AT 45° TO DRUM VENT HOLES (ITEM 10, R-RO-H-0004).

DRUM ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	REQ'D
8	R-R4-H-0057	RESERVOIR PACKING CANISTER	1
7	COML	ALLEN HD. SCREW #10-24 X 2" 304 S/S	4
6	COML	WASHER 1-1/2"OD X 1/4"ID X 1/16" THICK 304 S/S	4
5	COML	THERMAL CERAMICS "CERABLANKET" INSERT	AR
4	COML	FIBERFRAX HSA COMPOSITE 12" X 12" X 1/2"	2
3	R-R2-H-0009	TOP FIBERBOARD ASSEMBLY	1
2	R-R2-H-0009	LOWER FIBERBOARD ASSEMBLY	1
1	R-RO-H-0004A	DRUM	1

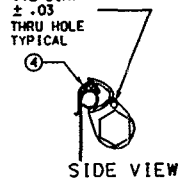
THIS DRAWING CONTAINS INFORMATION ON SHIPPING PACKAGES

REVISIONS REQUIRE DESIGN AGENCY - PACKAGING & TRANSPORTATION GROUP AT SRS APPROVAL

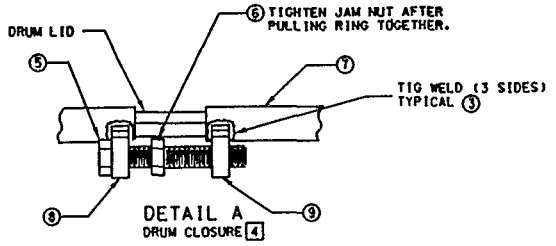


DETAIL B

IDENTIFICATION PLATE

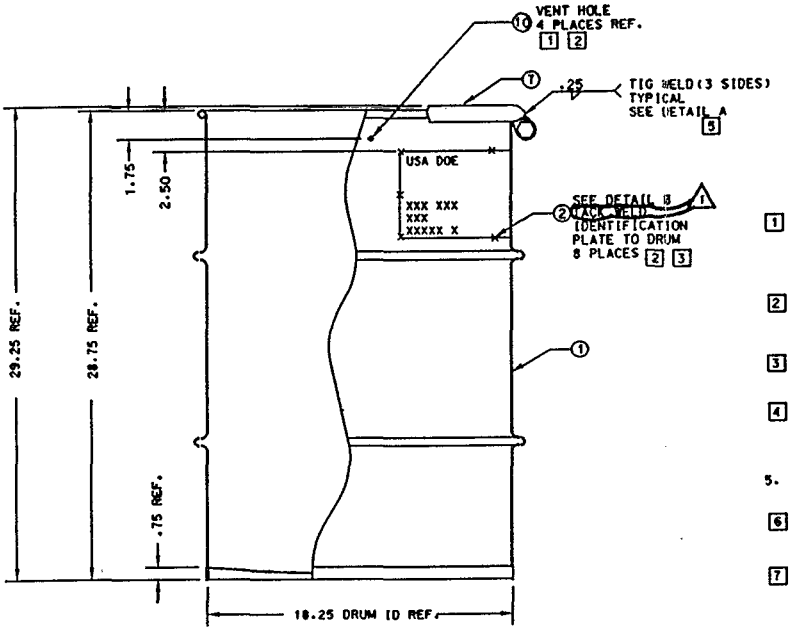


SIDE VIEW



DETAIL A

DRUM CLOSURE 4



R-RO-H-0004A

DRUM DETAIL

NOTES: UNLESS OTHERWISE SPECIFIED

1. DRILL A 3/8" DIA. HOLE (4 REQUIRED) AT LOCATION INDICATED EQUALLY SPACED AROUND DRUM PERIPHERY. PLUG EACH HOLE WITH A BPF CAPLUG 3/8 (ITEM 10). DIMPLE DRUM LOCALLY TO ALLOW CLEARANCE BETWEEN FIBERBOARD COVER ASSEMBLY AND CAP PLUG WHEN INSERTING THE COVER ASSEMBLY.
2. FORM ID PLATE (ITEM 2) TO CONTOUR OF DRUM. PLACE TOP EDGE OF IDENTIFICATION PLATE 2-1/2" ±1/4" FROM TOP OF RIM OF DRUM. AFTER WELDING CAULK EDGES OF ID PLATE WITH CLEAR SILASTIC.
3. ID PLATE (ITEM 2) CAN BE LOCATED ANYWHERE AROUND DRUM PERIPHERY APPROXIMATELY CENTERED BETWEEN TWO VENT HOLES.
4. DRUM IS TO BE CLOSED BY MEANS OF A BOLTED CLOSURE RING (ITEM 7) WITH DROP FORGED LUGS, ONE OF WHICH IS THREADED (ITEM 9), AND HAVING A BOLT (ITEM 5) AND NUT (ITEM 6). DRUM CLOSURE IS SHOWN IN "DETAIL A". HOLES FOR A SECURITY WIRE TO BE PROVIDED AS SHOWN.
5. WHEN WELDING LUGS, PLACE LUGS ALONG THE SAME ℄ AND PERPENDICULAR TO RING SURFACE WITH ENDS OF RING IN PLANAR ALIGNMENT.
6. XX IS TO BE YEAR OF MANUFACTURE. XXXX TO BE SUPPLIED BY SRS PURCHASE ORDER. STAMPED LETTERS TO BE FILLED WITH BLACK ENAMEL PAINT.
7. STENCIL ON DRUM: RETURN TO SRS, BLDG-234-H, AIKEN S.C.

ITEM	PART NUMBER	DESCRIPTION	QTY
10	COML	CAPLUG BPF 3/8	4
9	COML	DROP FORGED LUG, THREADED, 5/8"-11UNC, ASTM A-182 F304SS	1
8	COML	DROP FORGED LUG, UNTHREADED, ASTM A-182 F304SS	1
7	COML	CLOSURE RING, 12 GAUGE, ASTM SA-167 OR EQUAL S/S	1
6	COML	NUT, 5/8"-11UNC-2B ASTM A-194, GRADE 8C	1
5	COML	BOLT 5/8"-11UNC-2A X 4" LONG, ASTM A-193, GRADE B8C, CLASS1	1
4	COML	1/4" TO 3/8" THK (UNCOMPRESSED) CLOSED-CELL NEOPRENE OR SILICONE SPONGE RUBBER GASKET, LIGHT DENSITY	1
3	COML	WELD WIRE FILLER, AWS 308, ER 308, SAF5.4	AR
2	DETAIL B	IDENTIFICATION PLATE, 304 S/S 16 GA. PLATE	1
1	COML	30 GAL. FULL-REMOVABLE HEAD DRUM, 18 GA. ASTM SA-240 GRADE 304 S/S. SPECIFICATIONS UNLESS OTHERWISE NOTED TO BE PER DOT-17H (49 CFR 178 AS OF 10/1/91)	1

1 THIS DRAWING WAS PREPAIRED BY SRTC ETF GROUP FOR SRTC P&T. THE DESIGN GROUP.

E & PD Dwg. No. R RO H 0004

PROJ.	REV. NO.	DATE	REVISION	PREP'D	CHK'D	DES. AG.	TRIT. PROD.	TRIT. TECH.
X1234PROD	0	9-29-93	ORIGINAL ISSUE	SEE MICROFILM	COPY FOR SIGNATURE			
SR-101	1	10/21/96	INCORPORATED DCF # M-DCF-H-05460 BY EES.	ME MORGAN	MB FLOWERS	EXB	CR JOHNSON	DA MARKLEY

REFERENCE DRAWINGS
R-R4-H-0057
R-R2-H-0009

REFERENCE STANDARDS

TOLERANCES

UNITED STATES DEPARTMENT OF ENERGY

SAVANNAH RIVER SITE

BLDG. NO.	SITE CLEARANCE NO.	DESIGN AREA NO.	DESIGN GROUP
234-H	N/A	N/A	SRTC P&T GROUP

TITLE

INERT RESERVOIR PACKAGING (SR-101)

DRUM ASSEMBLY AND DETAILS

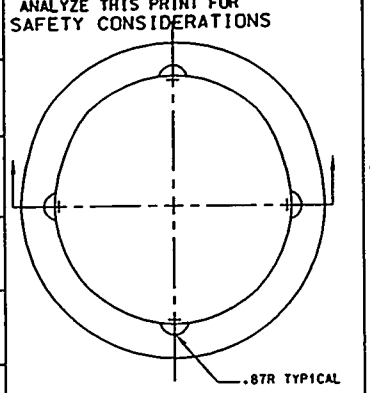
(U)

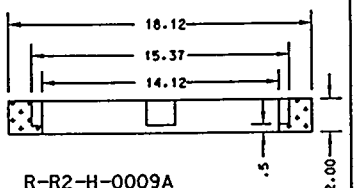
SCALE	SRS DRAWING NO.	SHEET NO.
NONE	N/A	01 OF 01

LATEST REVISION ON THIS DRAWING 1

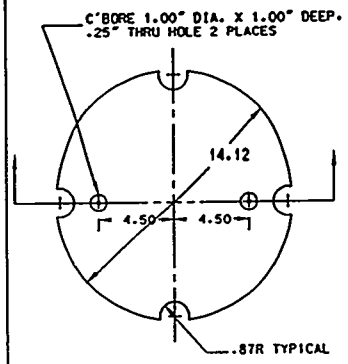
(This page intentionally left blank)

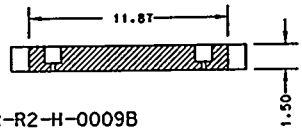
ANALYZE THIS PRINT FOR SAFETY CONSIDERATIONS



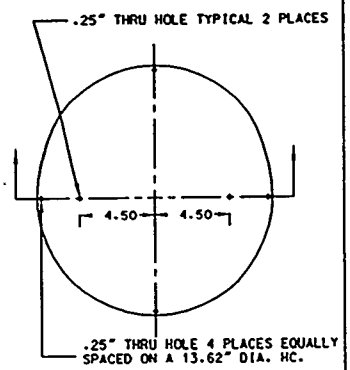


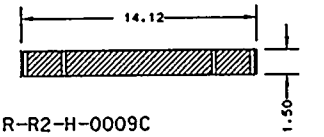
R-R2-H-0009A
MATERIAL: KAOWOOL M BOARD



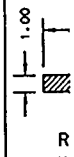


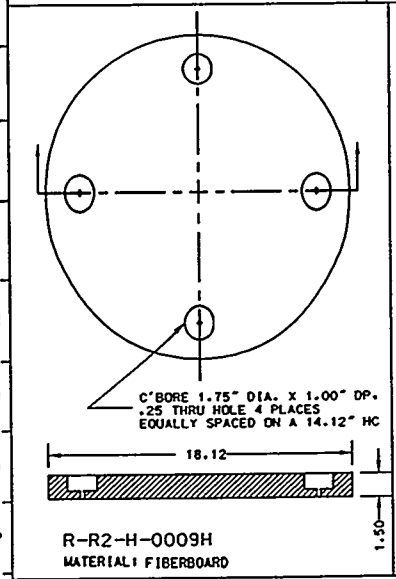
R-R2-H-0009B
MATERIAL: FIBERBOARD



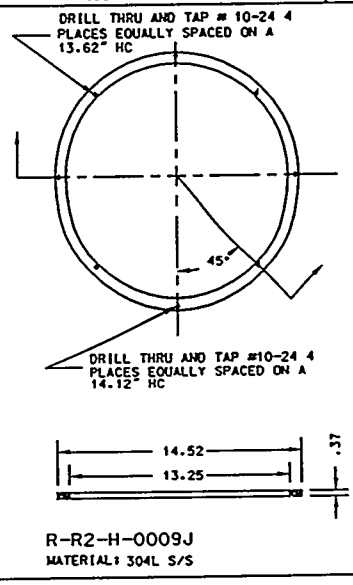


R-R2-H-0009C
MATERIAL: FIBERBOARD

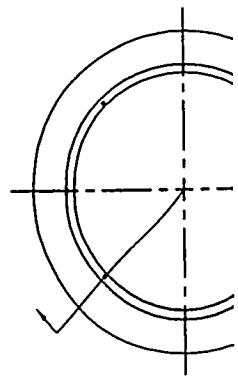


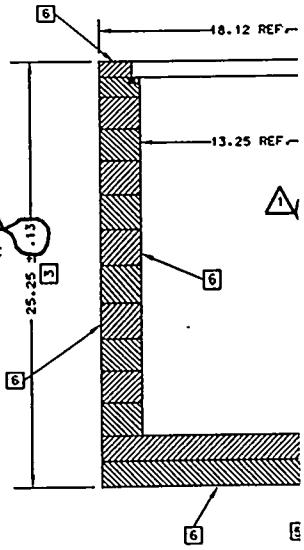


R-R2-H-0009H
MATERIAL: FIBERBOARD



R-R2-H-0009J
MATERIAL: 304L S/S





R-R2-H-0009L
LOWER PACKING ASSEMBLY

NOTES:

1. FIBERBOARD SHALL BE SOLID INDUSTRAL CANE FIBERBOARD MANUFACTURED TO THE ASTM SPEC. C-208-72 GRADE: ROOF INSULATING BOARD, AND HAVING A DENSITY IN THE RANGE OF 15 TO 18 LBS. PER CUBIC FOOT, PER 49 CFR 178.354-3(C)(1) OF 10/1/91.

2. POSITION TOP OF ROD WITH THREAD ADHESIVE (ITEM 9) SUCH THAT ROD TIP IS FLUSH WITH TOP OF SUPPORT PLATE (ITEM 6) PRIOR TO TORQUING BOTTOM NUT ADD THREAD ADHESIVE.

3. AT FIBERBOARD ASSEMBLY, ADD OR REMOVE MATERIAL AS REQUIRED TO OBTAIN DIMENSIONS SHOWN.

4. ALL JOINTS BETWEEN FIBER DISCS SHALL BE SECURLY GLUED USING TYPE-M ADHESIVE, (MIRACLE ADHESIVES, BELLMORE NY 11710), OR EQUAL.

5. FILL 1.75 DIA. C'BORE WITH FIBERBOARD PLUG GLUED IN PLACE AFTER NUTS AT BOTTOM ARE TORQUED. FOUR PLACES.

6. AFTER FIBERBOARD ASSEMBLY, ALL EXPOSED FIBER SURFACES SHALL BE COATED WITH WHITE VINYL ACRYLIC MASTER WEATHER COATING. SUGGESTED VENDORS:

   VAMASCO CORP. NITRO WV 25143
   VAMASCO COATING WC-7

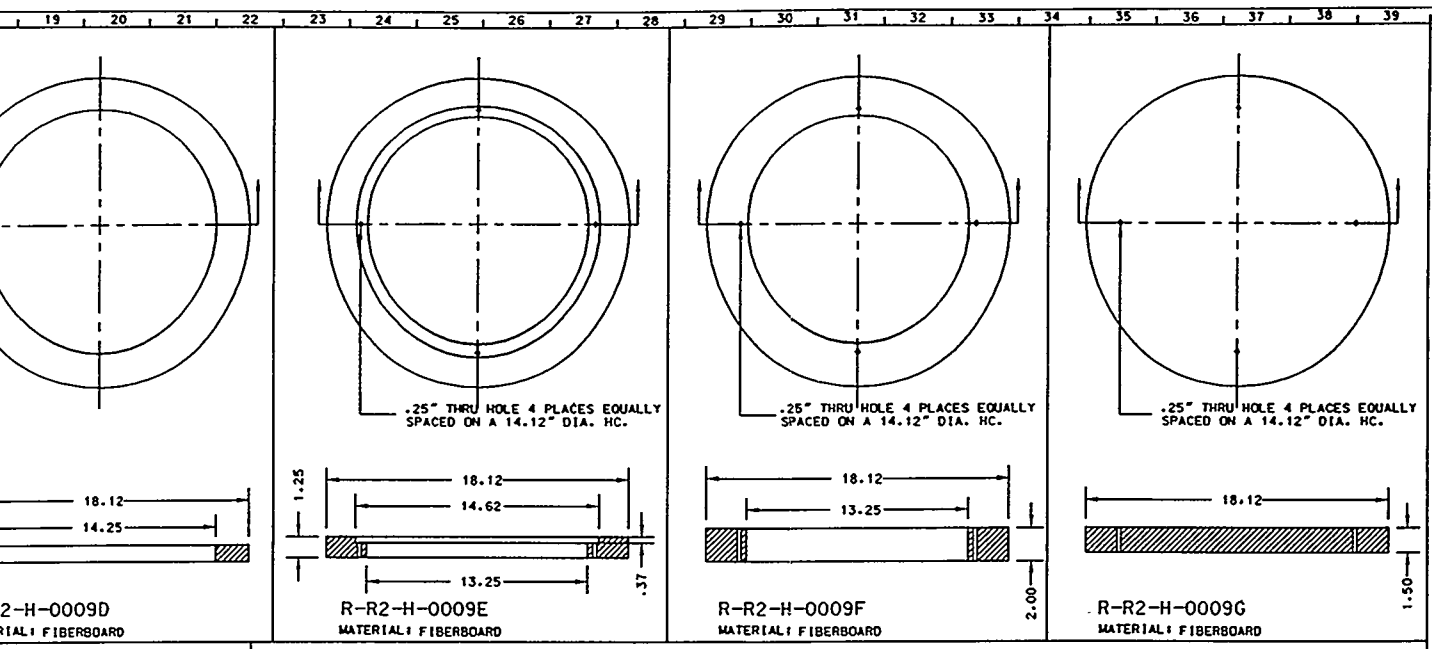
   CHILDERS CO.
   CHILDERS COATING CP-10

7. ALL FIBERBOARD TOL. ARE ± .06. ALL HOLE DIA. AND HOLE LOCATION TOL. ARE ± .06 UNLESS OTHERWISE SPECIFIED

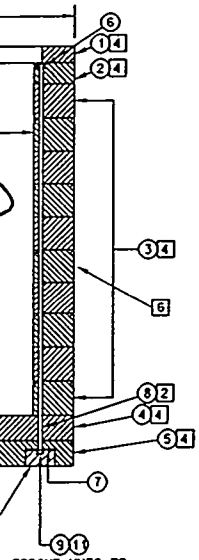
ITEM	PART NUMBER	DESCRIPTION	REQ'D	
12	COML	VINYL ACRYLIC MASTER WEATHER COATING, WHITE	AR	6
11	COML	NUT #10-24, 304 S/S	4	
10	COML	TYPE-M ADHESIVE	AR	4
9	COML	THREAD ADHESIVE LOCTITE #242 OR EQUAL	AR	2
8	COML	ROD 304 S/S, 3/16 OD X 23 3/4 LONG THREADED 10-24, ONE INCH EACH END	4	
7	COML	WASHER 1 1/2"OD X 1/4"ID X 1/16" THICK 304 S/S	4	
6	R-R2-H-0009J	S/S SUPPORT RING	1	
5	R-R2-H-0009H	FIBERBOARD DISC PER NOTE 1	1	
4	R-R2-H-0009G	FIBERBOARD DISC PER NOTE 1	1	
3	R-R2-H-0009F	FIBERBOARD DISC PER NOTE 1	10	
2	R-R2-H-0009E	FIBERBOARD DISC PER NOTE 1	1	
1	R-R2-H-0009D	FIBERBOARD DISC PER NOTE 1	1	

THIS DRAWING CONTAINS INFORMATION ON SHIPPING PACKAGES

REVISIONS REQUIRE DESIGN AGENCY - PACKAGING & TRANSPORTATION GROUP AT SRS APPROVAL



2-H-0009D
RIAL: FIBERBOARD



NOTES:

1. FIBERBOARD (ITEMS 2 AND 3) SHALL BE SOLID INDUSTRAL CANE FIBERBOARD MANUFACTURED TO THE ASTM SPEC. C-208-72 GRADE: ROOF INSULATING BOARD, AND HAVING A DENSITY IN THE RANGE OF 15 TO 18 LBS. PER CUBIC FT. PER 49 CFR 178.354-3(C)(1) OF 10/1/91. FABRICATOR SHALL FURNISH MATERIAL CERTIFICATE.

2. AT FIBERBOARD ASSEMBLY THE HEIGHT MUST BE ADJUSTED BY ADDING OR REMOVING MATERIAL TO OBTAIN STACK TOL. OF ± .13".

3. CUT LENGTH AS REQUIRED FOR 12" FREE LENGTH. STRAP TO FOLD FLAT. PROVIDE FOLDS AND PUNCH 1/4" DIA. HOLES (TWO REQUIRED) FOR ATTACHING TO SCREWS (ITEM 4).

4. ALL JOINTS BETWEEN FIBER DISCS SHALL BE SECURELY GLUED USING TYPE-W ADHESIVE. (MIRACLE ADHESIVES, BELLMORE NY 11710). OR EQUAL.

5. ATTACH STRAP (ITEM 7) TO SCREWS (ITEM 4) BELOW TOP WASHER. INSERT THRU DISC (ITEM 3) AND APPLY THREAD ADHESIVE (ITEM 8) TO SCREW THREADS. TORQUE NUT (ITEM 5) TO 10 IN-LBS. TWO PLACES.

6. AFTER ASSEMBLY ALL EXPOSED FIBER SURFACES SHALL BE COATED WITH WHITE VINYL ACRYLIC MASTER WEATHER COATING: SUGGESTED VENDORS:

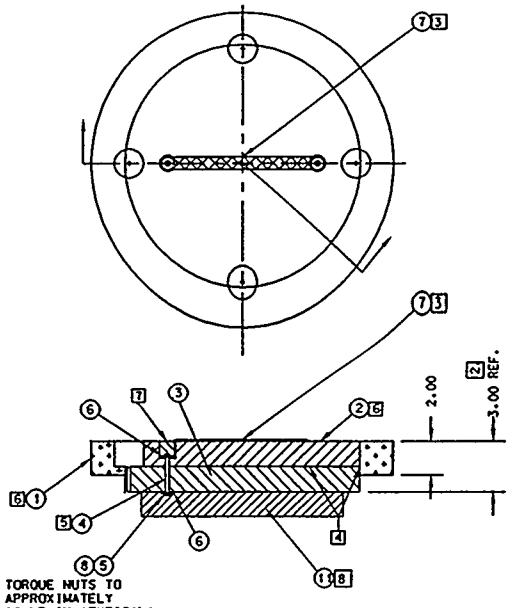
   VAMASCO CORP. NITRO WV 25143
   VAMASCO COATING WC-7

   CHILDERS CO.
   CHILDERS COATING CP-10

7. FILL 1" C'BORE WITH FIBERBOARD PLUG. GLUED IN PLACE (TWO PLACES) AFTER SCREWS ARE INSTALLED.

8. GLUE ITEM 11 IN-PLACE AS SHOWN AFTER FIBERBOARD IS COATED WITH MASTER WEATHER COATING PER NOTE 6.

9. ALL FIBERBOARD TOL. ARE ± .06. ALL HOLE DIA. AND HOLE LOCATION TOL. ARE ± .06 UNLESS OTHERWISE SPECIFIED



R-R2-H-0009K
TOP PACKING ASSEMBLY

	11	COML	12" DIA. X (-1/2" THICK POLYURETHANE FOAM. (1.5-2 LB/FT³. FLEXIBLE, OPEN CELL.	1
6	10	COML	VINYL ACRYLIC MASTER WEATHER COATING. WHITE	AR
4	9	COML	TYPE-W ADHESIVE PER NOTE 4	AR
	8	COML	THREAD ADHESIVE LOCTITE #242 OR EQUAL	AR
3	7	COML	STRAP HANDLE. 3/4" WIDE. NO. 2 FLAT NYLON WEBBING. BLACK	1
	6	COML	WASHER 3/4"OD X 1/4"ID X 1/16" THICK 304 S/S	4
	5	COML	NUT #10-24 304 S/S	2
	4	COML	BINDER HEAD SCREW #10-24 X 2-3/4 LONG 304 S/S	2
	3	R-R2-H-0009C	FIBERBOARD DISCPER NOTE 1	1
	2	R-R2-H-0009B	FIBERBOARD DISCPER NOTE 1	1
	1	R-R2-H-0009A	CERAMIC FIBER DISC "KAOWOOL M BOARD" THERMAL CERAMICS, AUGUSTA GA. 30903	1
ITEM		PART NUMBER	DESCRIPTION	REQ'D

THIS DRAWING WAS PREPAIRED BY SRTC ETF GROUP FOR SRTC P&T. THE DESIGN GROUP.

E & PD DWG. NO. R R2 H 0009

PROJ.	REV. NO.	DATE	REVISION	PREP'D	CHK'D	DES. AG.	TRIT. PROJ.	TRIT. TECH.
KT234PROJ	0	9-29-93	ORIGINAL ISSUE	SEE MICROFILM COPY FOR SIGNATURES				
SR-101	1	10/21/98	INCORPORATED DCF # M-DCF-H-05460 BY EES.	MZ MORGAN	JO FLOWERS	EKB	CR JOHNSON	GA MATHIS

REFERENCE DRAWINGS	
R-R4-H-0057	
R-RO-H-0004	

REFERENCE STANDARDS

UNITED STATES DEPARTMENT OF ENERGY

SAVANNAH RIVER SITE

BLDG. NO.	SITE CLEARANCE NO.	DESIGN AREA NO.	DESIGN GROUP
234-H	N/A	N/A	SRTC P&T GROUP

TITLE

INERT RESERVOIR PACKAGING (SR-101)
FIBERBOARD ASSEMBLY AND DETAILS
(U)

SCALE	SRS DRAWING NO.	SHEET NO.
NONE	N/A	01 OF 01

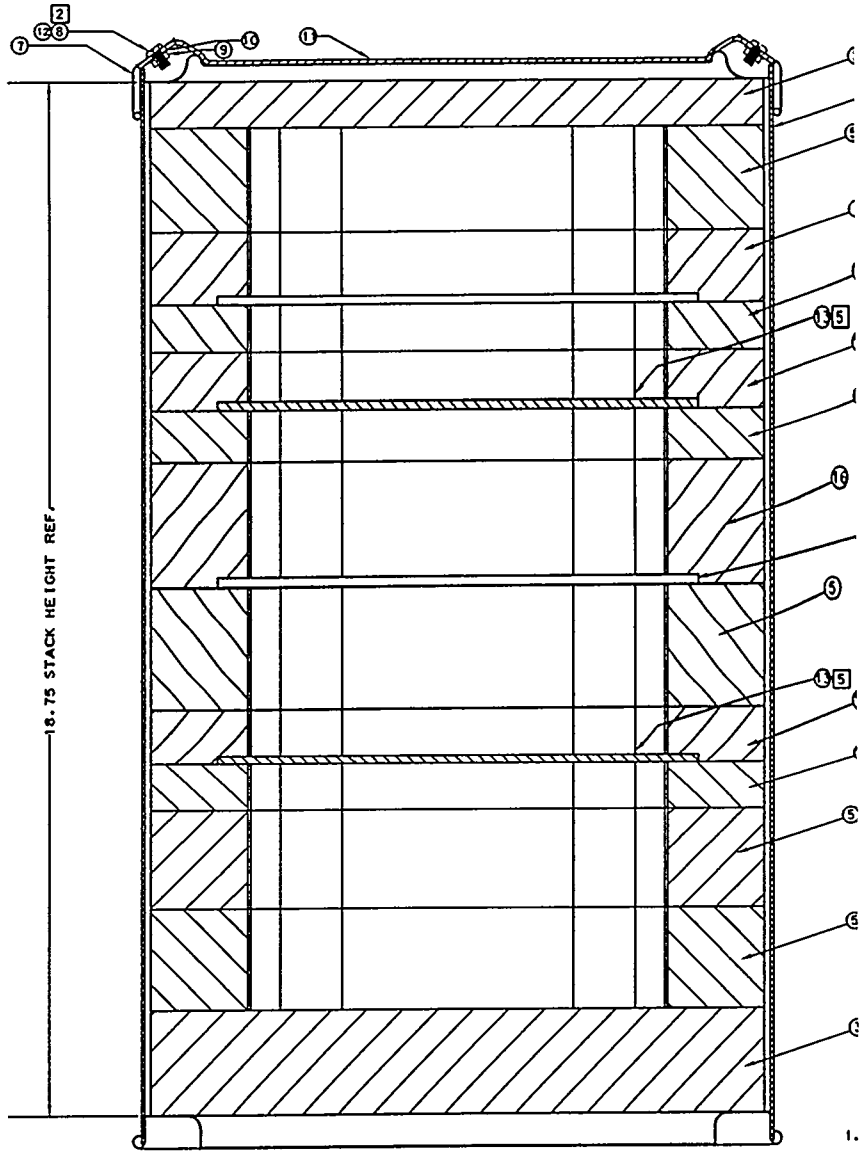
LATEST REVISION ON THIS DRAWING (1)

ERANCES NOTED

MENSIONS IN CHES

(This page intentionally left blank)

ANALYZE THIS PRINT FOR
SAFETY CONSIDERATIONS



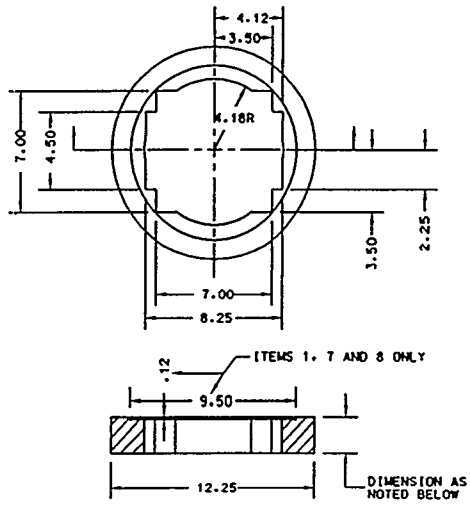
ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION	REQ'D
16	R-R4-H-0057H	FOAM DISCS 2" THICK	1
15	R-R4-H-0057G	FOAM DISCS 1" THICK	2
14	R-R4-H-0057F	FOAM DISCS 1" THICK	2
13	COML	PLYWOOD DISC 1/8" THICK X 9- 1/2" DIA	2
12	COML	THREAD ADHESIVE LOCTITE #242 OR EQUAL	AR
11	COML	NO. 2 FLAT NYLON WEBBING, BLACK, 3/4" WIDE X 16" LONG	1
10	COML	WASHER #10, 304 S/S	2
9	COML	NUT #10-24, 304 S/S	2
8	COML	SCREW BINDER HD. #10-24 X 1/2" LONG, 304 S/S	2
7	R-R4-H-0057 J	LIFTING STRAP LUGS	2
6	COML	FIBERBOARD DRUM, GREIF BROS ECONOMY BRAND SIZE FD-1	1
5	R-R4-H-0057 E	FOAM DISCS 2" THICK	4
4	R-R4-H-0057 D	FOAM DISCS 3/4" THICK	1
3	R-R4-H-0057 C	SOLID FOAM DISCS 2" THICK (NO OPENING INSIDE)	1
2	R-R4-H-0057 B	SOLID FOAM DISCS 3/4" THICK (NO OPENING INSIDE)	1
1	R-R4-H-0057 A	FOAM DISCS 1-1/4" THICK	1

THIS DRAWING CONTAINS INFORMATION ON SHIPPING PACKAGES

REVISIONS REQUIRE DESIGN AGENCY - PACKAGING & TRANSPORTATION GROUP AT SRS APPROVAL

TOLE
AS
ALL DIM
INC



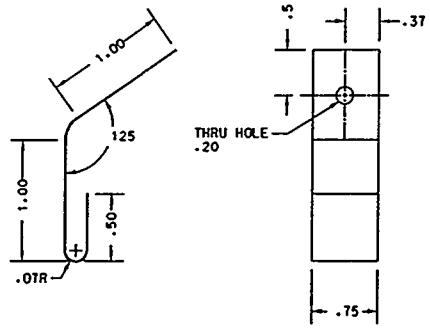
R-R4-H-0057A THRU H

NOTES:

1. MATERIAL: DOW ETHAFOAM MI POLYETHYLENE FOAM.

2. TOLERANCES FOR OD AND THICKNESS OF DISCS SHALL BE ± .06
ALL INSIDE TOLERANCES OF DISC SHALL BE ± .06.

8	R-R4-H-0057H	FOAM DISCS 2" THICK	1
7	R-R4-H-0057G	FOAM DISCS 1" THICK	2
6	R-R4-H-0057F	FOAM DISCS 1" THICK	2
5	R-R4-H-0057E	FOAM DISCS 2" THICK	4
4	R-R4-H-0057D	FOAM DISCS 3/4" THICK	1
3	R-R4-H-0057C	SOLID FOAM DISCS 2" THICK (NO OPENING INSIDE)	1
2	R-R4-H-0057B	SOLID FOAM DISCS 3/4" THICK (NO OPENING INSIDE)	1
1	R-R4-H-0057A	FOAM DISCS 1-1/4" THICK	1
ITEM	PART NUMBER	DESCRIPTION	QTY



BREAK ALL SHARP EDGES. ROUND CORNERS SLIGHTLY.

R-R4-H-0057J LIFTING STRAP LUGS

MATERIAL: 18 GA. 304 S/S SHEET METAL

TOLERANCES:
ALL TOLERANCES THIS PART TO BE ± .03.

THIS DRAWING WAS PREPAIRED BY SRTC ETF GROUP FOR SRTC P&T. THE DESIGN GROUP.

E & PD DWG. NO. R R4H 0057

PROJ.	REV. NO.	DATE	REVISION	PRP'D	CHK'D	DES. AG.	WIT. PROB.	WIT. TECH.
KT234PROD	0	9-29-93	ORIGINAL ISSUE	SEE MICROFILM COPY FOR SIGNATURES				
SR-101	1	10/21/96	INCORPORATED DCF # M-DCF-H-05460 BY EES		NO FLOORS	ETD	CF JOHNSON	CA WATKINS

REFERENCE DRAWINGS
RR2H0004
RR2H0009

REFERENCE STANDARDS

UNITED STATES DEPARTMENT OF ENERGY
SAVANNAH RIVER SITE

BLDG. NO.	SITE CLEARANCE NO.	DESIGN AREA NO.	DESIGN GROUP
234-H	N/A	N/A	SRTC P&T GROUP

TITLE
INERT RESERVOIR PACKAGING (SR-101)
RESERVOIR PACKAGING CANISTER DETAILS
(U)

SCALE	SRS DRAWING NO.	SHEET NO.
NONE	N/A	01 OF 01

LATEST REVISION ON THIS DRAWING (1)

(This page intentionally left blank)

FSCM No. 14062

P12346
Page 1 of 6

Procurement Specification for DOT-17H 30-Gal Drum

Page	1	2	3	4	5	6
Issue	9	6	5	7	1	1

Issue	Revision Description	Class Date	Engr	Chkr	Review
9	Deleted record of previous revisions. Revised and retyped. Added sheets 5 and 6.	9-21-88	FEA	RCO	WAH

RF - PE CONTROLLED DWG

REVIEWED FOR CLASSIFICATION:

BY: W. A. HAEFELE, SENIOR PRINICIPAL ENGINEER

DATE: 09/07/88

UNCLASSIFIED

1. GENERAL

1.1 Scope. This specification gives the minimum requirements for a DOT specification 17H full-open-head steel drum of 30-gallon capacity.

1.2 Intended Use (Reference). Drums will be used as the outside component of a reusable shipping container. Inside dimensions rather then capacity must be controlled to assure a proper fit with rigid, close fitting inside components.

1.3 Required Documents

Number	Title
49 CFR 178	Hazardous Materials Regulations of the Department of Transportation, Specification 17H
ANSI MH2.13	Specifications for 30-Gallon Full-Removable-Head Universal Drum (DOT-17H)

2. REQUIREMENTS

2.1 General. All requirements of 178.118 (DOT-17H) and Section 3 (Construction) of MH2.13 shall be met.

2.2 Dimensional. Minimum inside dimensions shall be controlled such that a right circular cylinder 18.12-inches and 27.21-inches long can be placed within the drum (without external rounding) and the cover closed as for shipping.

REVIEWED FOR CLASSIFICATION:

BY: W. A. HAEFELE, SENIOR PRINCIPAL ENGINEER

DATE: 09/07/88

2.3 Closure. Closure shall meet the requirements of 178.118-8 except a 5/8-inch bolt, and jam-nut required. Bolt shall be SAE grade 2 or better with a minimum tensile strength of 12,900 pounds. A seal wire hole of .12-inch approximate diameter shall be located approximately .5-inches from the threaded end. The lug-to-locking ring weld shall meet the requirements of Figure 2. The ring shall have a .18-inch minimum gap when assembled for use and the bolt torqued to 45 foot-pounds.

2.4 Gasket. A gasket adequate to prevent leakage shall be permanently attached to the lid. Any glue shall be of the non-hardening type.

2.5 Finish. All interior and exterior surfaces shall be coated with a rust-inhibiting metal primer. Exterior surfaces shall be finished with a black enamel. (Note: This requirement is not for stainless steel drums)

2.6 Integrity. Drums shall meet the drop, hydrostatic pressure, and leak tests specified in 49 CFR 178. Test samples shall be selected at random from each production lot. Testing may be performed by the manufacturer or upon receipt, or both.

3. QUALITY PROVISIONS.

3.1 Certification. The application of the DOT specification number and the manufacturers identification symbol in the permanent head shall be understood to certify that the drum complies with the requirements of this specification.

3.2 Acceptance. The buyers acceptance will be based on a detailed dimensional inspection, visual examination, and functional tests on a representative sample from each lot of drums supplied. Receiving inspection will include, but not be limited to those items listed in Figure 1.

REVIEWED FOR CLASSIFICATION:

BY: W. A. HAEFELE, SENIOR PRINCIPAL ENGINEER

DATE: 09/07/88

UNCLASSIFIED

4.0 Packing and Shipping.

4.1 Good commercial packaging methods shall be used to assure damage-free delivery of product.

4.2 Items of hardware such as gaskets and bolts shall be assembled with each drum furnished.

REVIEWED FOR CLASSIFICATION:

BY: W. A. HAEFELE, SENIOR PRINCIPAL ENGINEER

DATE: 09/07/88

UNCLASSIFIED

FIGURE 1

DOT-17H 30-GALLON DRUM
INSPECTION REQUIREMENTS*

ITEM NO.	SPECIFICATION	INSPECTION ENTRY
1.	Lot number/quantity in lot	_____
2.	Identification numbers embossed in lower head per DOE specification	_____
	Record: Manufacturers symbol	_____
	Gauge/Capacity/Year	_____
	DOE specification	_____
	Other	_____
3.	.0428 min thickness, body and heads	_____
4.	18.12 min inside diameter x 27.21 min inside height w/cover on	_____
5.	.0946 min closure ring w/drop forged lugs and 5/8-inch bolt and nut	_____
6.	Lug weld satisfactory (visual), 1.5 min bead	_____
7.	.375 min convexity, both heads	_____
8.	Gasket satisfactory, record type and material	_____
9.	Overall workmanship satisfactory	_____
10.	Drop, pressure, and leak tests satisfactory	_____
11.	.18 min gap in locking ring per section 2 of P12346	_____
12.	12,900 min pounds bolt strength, seal wire hole satisfactory	_____

*This gives the minimum requirements for "Preliminary Determination" before first use as specified in DOE Order 5480.3.

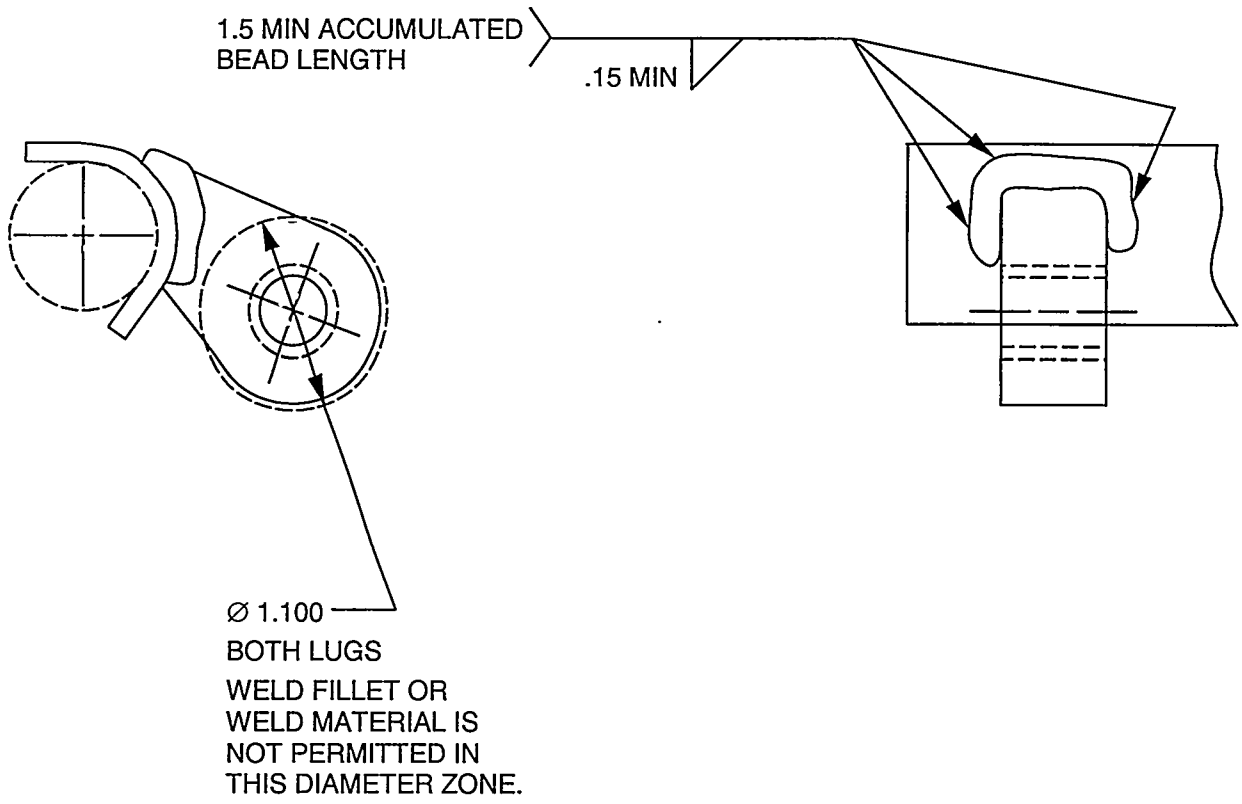
REVIEWED FOR CLASSIFICATION:

BY: W. A. HAEFELE, SENIOR PRINCIPAL ENGINEER

DATE: 09/07/88

UNCLASSIFIED

FIGURE 2



LUG ILLUSTRATION

REVIEWED FOR CLASSIFICATION:

BY: W. A. HAEFELE, SENIOR PRINCIPAL ENGINEER

DATE: 09/07/88

UNCLASSIFIED

Appendix 2

(This page intentionally left blank)

APPENDIX 2 LIST OF FORMULAS USED IN CALCULATING WALL STRESS AND BURST PRESSURE FOR THE RESERVOIRS

Sphere (thick or thin wall)

The maximum hoop stress formula used is from 49 CFR 178.65-7 (Spec. 39):

$$S = \frac{PD}{4t}$$

Where S is the wall stress (psi), P is the test pressure, and D is the outside diameter (in.).

The burst pressure formula for thick wall spheres (Ref. 1) is:

$$P_b = 2S_y\left(2 - S_y / S_u\right)\ln\left(r_o / r_i\right)$$

Where S_y is the yield strength (psi), S_u is the ultimate strength, r_o is the outer radius and r_i is the inner radius (in.). S_u and S_y are taken at the reservoir temperature.

Thick-wall Cylinder

(The definition of a thick-wall shell is when the ratio of the inner radius and the wall thickness is less than 10.)

The maximum hoop stress formula (Ref. 1) is:

$$S_h = P_i\left(1 + R^2\right)/\left(R^2 - 1\right)$$

Where S_h is the hoop stress (psi), P_i is the internal test pressure, and R is the ratio of the outer and inner radii.

The burst pressure formula (Ref. 1) is:

$$P_b = \left(2S_y / \sqrt{3}\right)\left(2 - S_y / S_u\right)\ln\left(r_o / r_i\right)$$

Where S_y is the yield strength (psi), S_u is the ultimate strength, r_o is the outer radius and r_i is the inner radius (in.). S_u and S_y are taken at the reservoir temperature.

Formulas that provide more conservative results can be used instead of these formulas.

References

1. Faupel, J. H., *Engineering Design*, John Wiley and Sons, New York, 1964.

(This page intentionally left blank)

Appendix 3

(This page intentionally left blank)

WESTINGHOUSE SAVANNAH RIVER COMPANY
INTER-OFFICE MEMORANDUM

SCS-CMG-930009
NON-CRITICAL DATA
92-095-0

NRTSC
Technology
On Time
On Target

FEBRUARY 23, 1993

TO: R. J. Gromada, 305-2A

FROM: S. J. Hensel, 773-42A
(5-9780)

Original Signed
J. W Pelfrey, Manager

2-23-93
Date

TRANSIENT THERMAL RESPONSE OF A SHIPPING DRUM AFTER A TWELVE HOUR SOLAR LOAD WITH RADIATIVE HEAT TRANSFER PART II (U)

The general purpose thermal analysis software P/Thermal was used to compute the transient thermal response of a shipping drum to a twelve hour solar loading. In this analysis the amount of stainless steel in the SR-101 drum was reduced by 90 percent. The material interface temperatures within the drum were of particular interest. The maximum computed temperature of the stainless steel surrounding the internal compartment was 123.7°F compared with 112.5°F for the case with 10 times as much steel.

cc: D. Hoang, 305-2A
G. Cadelli, 305-2A
J. R. Pelfrey, 773-42A
SCS-CMG FILE, 773-42A

SCS-CMG-930009
NON-CRITICAL DATA
92-095-0
P. 2 of 9

TRANSIENT THERMAL RESPONSE OF A SHIPPING DRUM AFTER A TWELVE HOUR SOLAR LOAD WITH RADIATIVE HEAT TRANSFER PART II (U)

A transient thermal analysis simulating a one day solar exposure of the SR-101 drum Was performed. The SR-101 drum is axisymmetric and consists of 5 materials as shown in Figure 1. To simplify modeling efforts and eliminate the presence of excessively large aspect ratio elements, the fiber cardboard and outermost stainless steel liner were neglected in the model. The outer stainless steel is only 60 mils thick and its affect on drum temperatures is negligible. The model and dimensions are shown in Figure 2. A total of 561 linear elements were used. The material property data used in this analysis is presented in Table 1. A stainless steel density 90 percent less than the nominal value was used in this analysis. This lowered the thermal inertia of the package and would be more representative of the packages with lighter loads. The general purpose thermal analysis software P/Thermal was used to simulate the transient.

The boundary conditions applied for this analysis are shown in Figure 3. The solar exposure was modeled using a constant solar heat flux on the exposed surfaces. The bottom portion of the drum was assumed to be insulated. Throughout the transient natural convection effects were modeled using two correlations for the top and side surfaces. Radiative heat transfer was simulated with a constant drum surface emissivity of 0.5. As requested by the customer, an ambient temperature of 100°F was used throughout the transient to Simulate convection and radiation effects. The initial temperature of the drum was 100°F.

The temperatures at the end of the twelve-hour transient are illustrated in Figure 4. As expected, the maximum temperatures occur along the drum upper surface because of the higher solar heat flux. The maximum temperature of the inner stainless steel at the 12 hour mark is 123.7°F, and it occurs along the drum centerline as expected. Previous results using the nominal density of stainless steel are shown in Figure 5. The inner temperatures are about 11°F higher in the latest analysis. An increased payload would marginally lower temperatures within the package.

The general-purpose thermal analysis software P/Thermal was used to compute the transient thermal response of a shipping drum to a twelve hour solar loading. As expected,

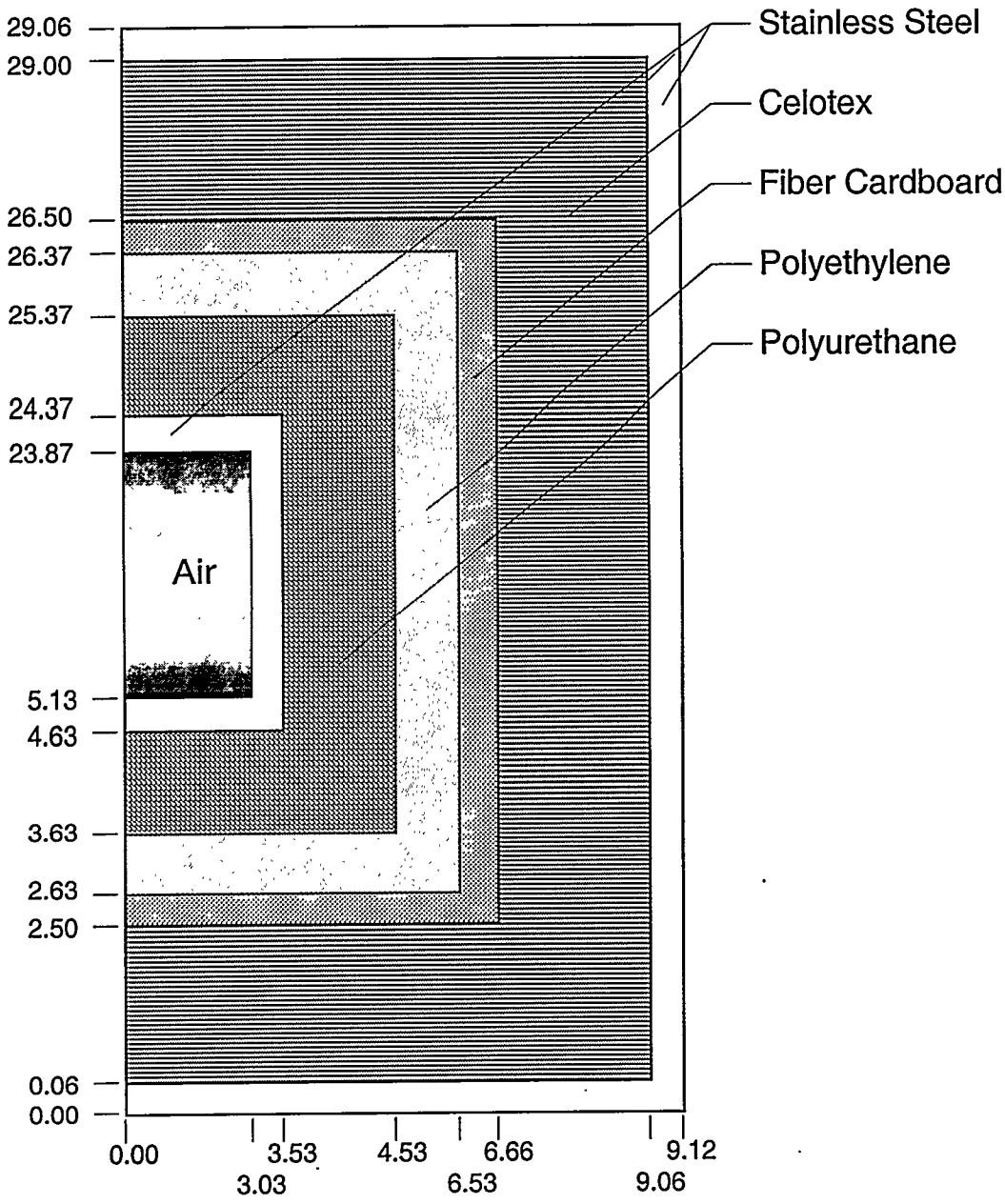
the peak temperatures occurred along the drum upper surface. The material interface temperatures within the drum were of particular interest. In the present analysis the density of stainless steel was reduced by 90 percent to simulate the lower payload packages. The maximum computed temperature of the stainless steel surrounding the internal compartment was 123.7°F. Previous analyses of the same package using the nominal stainless steel density gave an interface temperature of 112.5°F. The substantial decrease in stainless steel resulted in an 11°F temperature decrease in internal temperatures.

SCS-CMG-930009
NON-CRITICAL DATA
92-095-0
P. 4 of 9

TABLE 1

MATERIAL	CONDUCTIVITY	SPECIFIC HEAT	DENSITY
AIR	1.39e-02 @ 32°F 1.84e-02 @ 212°F 2.24e-02 @ 392°F	0.237	8.05e-02
STAINLESS STEEL	7.74 @ 32°F 9.43 @ 212°F 12.58 @ 932°F	0.12 @ 32°F 0.135 @ 752°F	49.44
POLYURETHANE	2.42E-02	0.42	3.75
POLYETHYLENE	0.239	0.55	5.84
CELOTEX®	0.034	0.36	17.28

UNITS are lbm-Btu-°F-ft

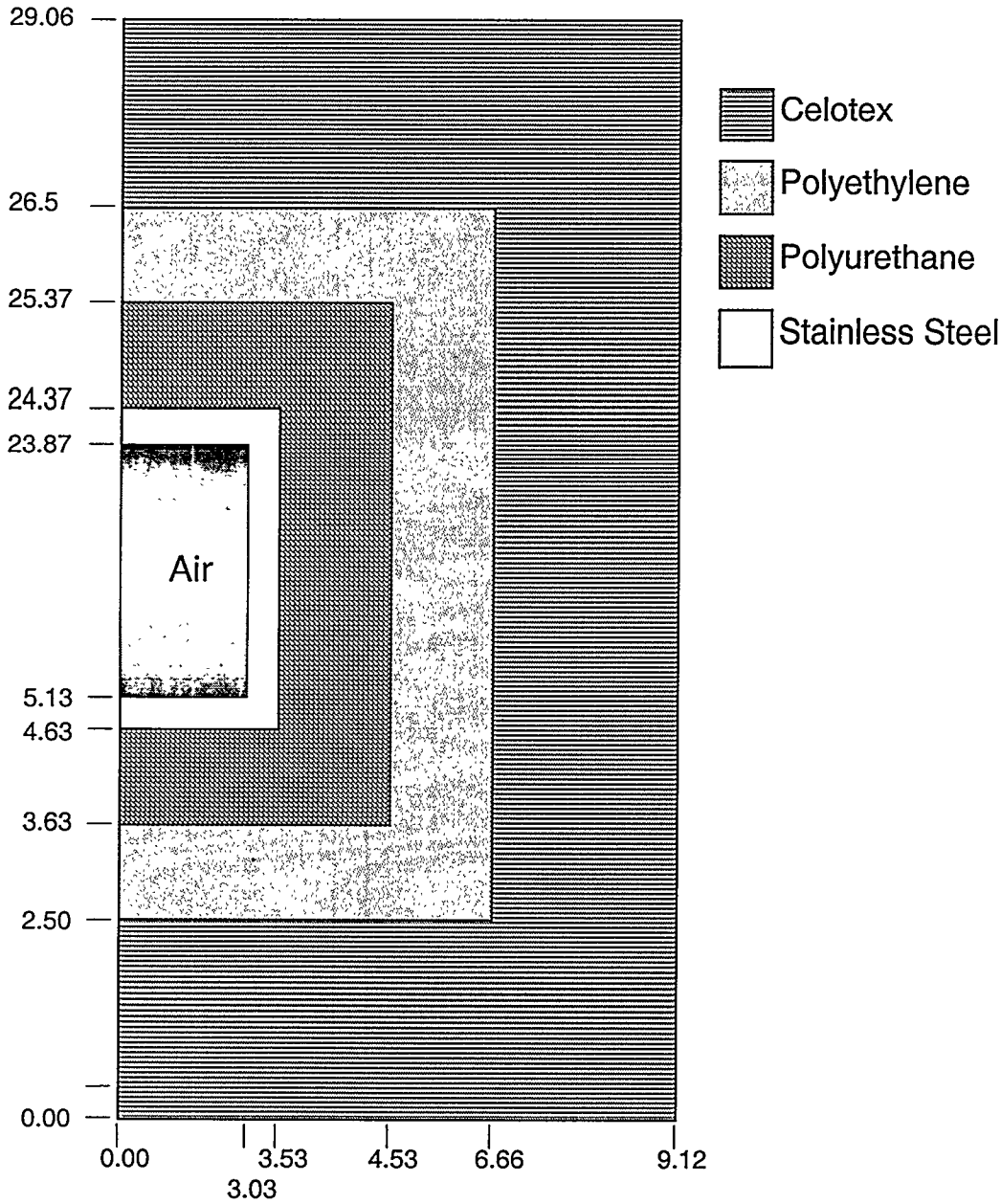


Notes: Figure (not scale): All dimensions in inches

FIGURE 1

SCS-CMG-930009
NON-CRITICAL DATA
92-095-0
P. 6 of 9

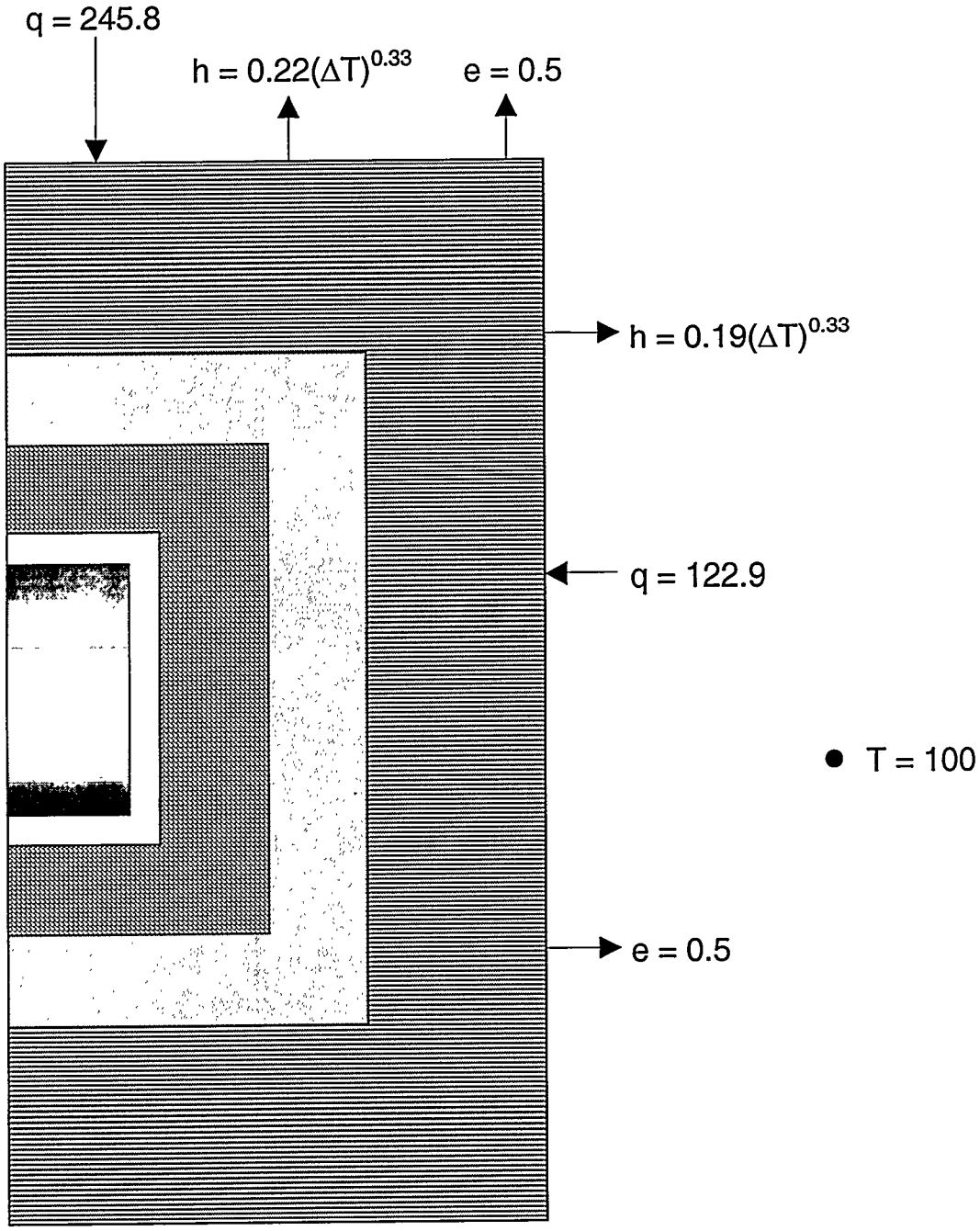
MODEL USED IN ANALYSIS



NOT TO SCALE
ALL DIMENSIONS IN INCHES

FIGURE 2

MODEL AND BOUNDARY CONDITIONS



ALL QUANTITIES IN Btu-hr-ft-°F

FIGURE 3

TEMPERATURES AT 12 HOURS IN °F
STAINLESS STEEL REDUCED BY FACTOR OF 10

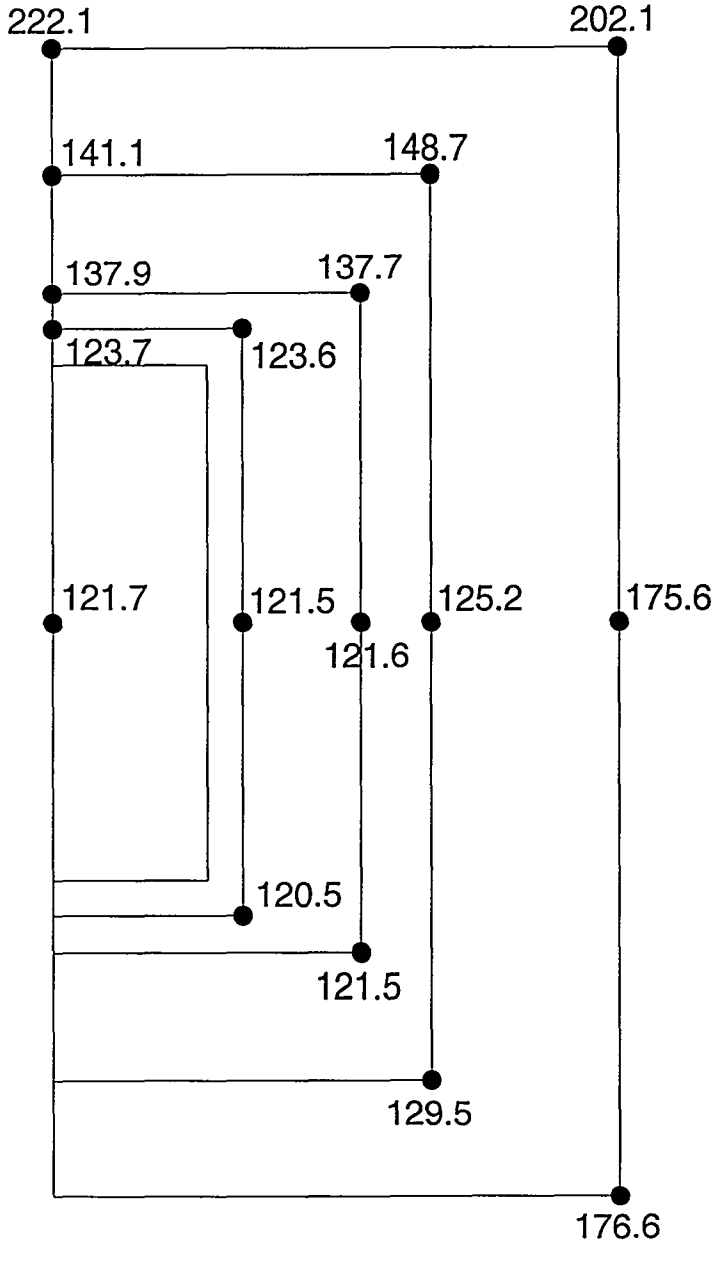


FIGURE 4

TEMPERATURES AT 12 HOURS IN °F
NOMINAL STAINLESS STEEL DENSITY

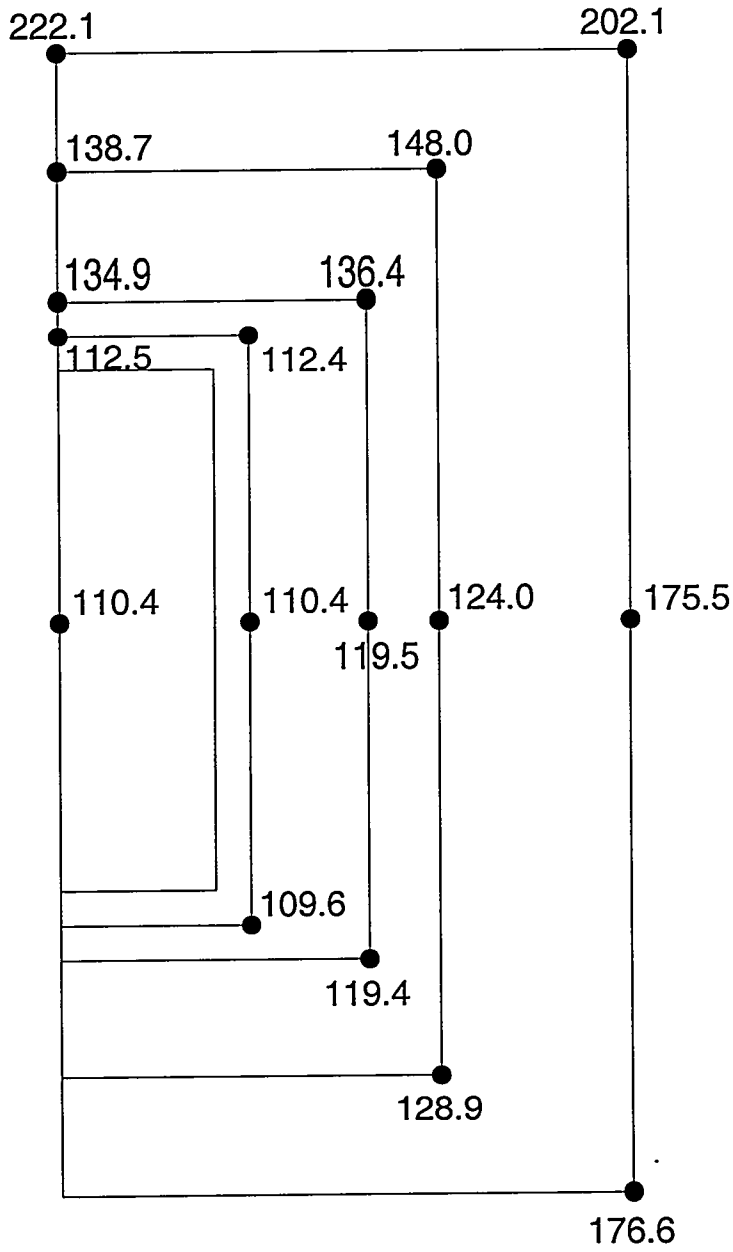


FIGURE 5

(This page intentionally left blank)

Appendix 4

(This page intentionally left blank)

APPENDIX 4 LISTING OF RESERVOIRS AND SQUIB VALVES QUALIFIED FOR SHIPMENT IN THE SR-101 PACKAGE AS OF NOVEMBER, 1998

The contents for the SR-101 Reservoir Package are qualified by comparison with the criteria listed in SAR Section IV.A.1.c and Section IV.B. The contents consist of the compressed gas, the reservoir (vessel containing the gas), attached squib valves (explosive release devices) and packing assemblies or fixtures. The qualification of the SR-101 contents is performed by the SRS tritium facility Cognizant Technical Function. The contents listed in this appendix have been pre-qualified for shipment in the SR-101. Any new proposed contents must be qualified by making a point-by-point comparison with SAR criteria controlling parameters such as reservoir shape, volume of gas, internal pressure, steel type, forging, and design of reservoir penetrations. The total weight of the contents can not exceed 25 lb.

Contents List
SR-101 Reservoir Package

CONTENTS	PART NUMBER	CONFIGURATION	UN NUMBER	LABELS
MC3572	211758-00	MC3572 (3 MAXIMUM) PROTECTIVE CAP, P/N 32552 (P/N Not on cap; cap furnished with P/N 211758-00) CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1957	FLAMMABLE GAS **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
MC3250A	211847-01	MC3250A RESERVOIR (1 MAXIMUM) PROTECTIVE CAP, P/N 453308-00 (P/N Not on cap; cap furnished with P/N 211847-01) SP992 STRONGBACK ASSEMBLY	UN1957	FLAMMABLE GAS **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
MC3250 TRA–S	211848-01	MC3250 TRA–S RESERVOIR (1 MAXIMUM) PROTECTIVE CAP, P/N 453308-00 (P/N not on cap; cap furnished with P/N 211848-01) SP992 STRONGBACK ASSEMBLY	UN1046	NON-FLAMMABLE GAS
MC3091A	211852-01	MC3091A (1 MAXIMUM) PROTECTIVE HOLDER, P/N 453269-00 (ALT P/N 32594) PROTECTIVE CAP, P/N 453308-00 (P/N Not on cap; cap furnished with P/N 211852-01) CARDBOARD BOX, 14 L in. × 6 in. W × 6 in. D	UN1957	FLAMMABLE GAS **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
MC3091 TRA–S	211853-01	MC3091 TRA–S (1 MAXIMUM) PROTECTIVE HOLDER, P/N 453269-00 (ALT P/N 32594) THREAD PROTECTOR PROTECTIVE CAP, P/N 453308-00 (P/N not on cap; cap furnished with P/N 211853-01) CARDBOARD BOX, 14 L in. × 6 in. W × 6 in. D	UN1046	NON-FLAMMABLE GAS
MC3251 TRA–S	211854-01	MC3251 TRA–S RESERVOIR (3 MAXIMUM) PROTECTIVE CAP, P/N 451276-00 PROTECTIVE COVER, P/N 368940-00 PROTECTIVE CAP, P/N 878154-00 (Alternate for P/N 368940-00, P/N not on cap) CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS 1.4S EXPLOSIVE

Contents List (continued) SR-101 Reservoir Package				
MC3503 TRA–S	211856-01	MC3503 TRA–S RESERVOIR (3 MAXIMUM) PROTECTIVE CAP, P/N 451276-00 PROTECTIVE COVER, P/N 368940-00 PROTECTIVE CAP, P/N 878154-00 (Alternate for P/N 368940-00, P/N not on cap) CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS 1.4S EXPLOSIVE
MC2597 TRA–S	211940-00	MC3503 TRA–S RESERVOIR (3 MAXIMUM) PROTECTIVE CAP, P/N 230091-00 (Alternate P/N 457188-00 per SXR N005SR97SL) CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS
MC3007A TRA	211955-00	MC3007 TRA (2 MAXIMUM) PROTECTIVE CAP, P/N 231998-01 PROTECTIVE CAP, P/N 454494-02, 03, 04 INSERT, SHIPPING CONTAINER, P/N 322147-01	UN1006	NON-FLAMMABLE GAS
MC4205	211990-00	MC4205 RESERVOIR (3 MAXIMUM) PROTECTIVE CAP 1, P/N 457225-00 PROTECTIVE CAP 2, P/N 457226-00 CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1957	FLAMMABLE GAS 1.4S EXPLOSIVE **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
MC4281–TRA	212028-00	MC4281–TRA (3 MAXIMUM) PROTECTIVE CONTAINER, P/N 456680-00	UN1957	FLAMMABLE GAS 1.4S EXPLOSIVE **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
MC3572–TRA SPECIAL	212094-00	MC3572–TRA SPECIAL (3 MAXIMUM) PROTECTIVE CAP (P/N not on cap; cap furnished with P/N 212094-00) CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS
MC4240–TRA SPECIAL	212095-00	MC4240–TRA SPECIAL (3 MAXIMUM) PROTECTIVE CAP, P/N 458518-00 CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS
MC3572–TRA He	212099-00	MC3572–TRA SPECIAL (3 MAXIMUM) PROTECTIVE CAP (P/N not on cap; cap furnished with P/N 212099-00) CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS

Contents List (continued) SR-101 Reservoir Package				
MC4240–TRA He	212100-00	MC4240–TRA SPECIAL (3 MAXIMUM) PROTECTIVE CAP, P/N 458518-00 CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00	UN1046	NON-FLAMMABLE GAS
MC4281–TRA He	212101-00	MC4281–TRA (3 MAXIMUM) PROTECTIVE CONTAINER, P/N 456680-00	UN1046	NON-FLAMMABLE GAS 1.4S EXPLOSIVE
MC3494 [1A SPECIAL]	420674-00	MC3494 [1A SPECIAL] (3 MAXIMUM) PROTECTIVE CAP (P/N not on cap) CONDUCTIVE BAG, 12 in. × 16 in., P/N 859395-00	UN1957	FLAMMABLE GAS 1.4S EXPLOSIVE **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
IM–81/2M–82 JTA (4Z Valve)	422532-00	1M–81/2M–82 JTA (3 MAXIMUM) CONDUCTIVE BAG, 12 in. × 16 in., P/N 859395-00	UN1006	NON-FLAMMABLE GAS 1.4S EXPLOSIVE
1K–100	423017-00	1K–100 RESERVOIR (3 MAXIMUM) PROTECTIVE CAP, P/N 422973-00 CONDUCTIVE BAG, 8 in. × 12 in., P/N 859392-00	UN1046	NON-FLAMMABLE GAS
IM–81/2M–82 JTA (18Z Valve)	423051-00	1M–81/2M–82 JTA (3 MAXIMUM) CONDUCTIVE BAG, 12 in. × 16 in., P/N 859395-00	UN1006	NON-FLAMMABLE GAS 1.4S EXPLOSIVE
VALVE ASSEMBLY, TRA (MC4213 TRA)	456004-00	MC4213 TRA (3 MAXIMUM) PROTECTIVE CONTAINER, P/N 456680-00	UN1957	FLAMMABLE GAS 1.4S EXPLOSIVE **DANGER:** DO NOT LOAD IN PASSENGER AIRCRAFT RADIOACTIVE (INNER CANISTER)
SP800 TRA with MC2599 Valve	K67767 (this P/N is to be used as the Kit Number)	SP800 TRA with MC2599 Valve CONDUCTIVE BAG, 10 in. × 14 in., P/N 859394-00 or CONDUCTIVE BAG, 12 in. × 16 in., P/N 859395-00 2–Plastic bags	UN1046	NON-FLAMMABLE GAS 1.4S EXPLOSIVE RADIOACTIVE (INNER CANISTER)
1X–102 JTA	423092-00	1X–102 JTA (2 MAXIMUM) PROTECTIVE CAP, P/N 231998-01 PROTECTIVE CAP, P/N 454494-02, 03, 04 INSERT, SHIPPING CONTAINER, P/N 322147-01	UN1006	NON-FLAMMABLE GAS
EMPTY	N/A	3–CELL CONFIGURATION WITH 2 PLYWOOD DISCS WITHOUT RESERVOIRS OR FOAM FILLER	N/A	EMPTY